MACHINE DESIGN

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Contents

Illusions Aid Appearance 23
By Harold Van Doren

Scanning the Field for Ideas 28

Flame Hardening Applications Show Steady Increase 30

Why Not Combine the Plastic with the Metal? 31
By J. Delmonte

Telescoping Lift Embodies Unique Drive 35
By J. B. Harrison

It's Time To Broadcast Facts Regarding Use of Machines (Editorial) 39

MACHINE DRIVES AND CONTROLS SUPPLEMENT

Attaining Speed, Power, Flexibility 21-S
By George Z. Griswold

When To Use the Shell-Type Motor 24-S
By O. F. Vea

Hydraulics Cannot Be Denied!—Part I 28-S
By Hans Ernst and Albert H. Dall

To Help Machine Sell—Use Quiet Drive 32-S
By John W. Greve

Looking Ahead! 35-S

Design Features in New Machines 36-S

Electronics Make Difficult Processes Simple 38-S

Nonmetallic Gears and Couplings Deaden Vibration 48-S

Men of Machines 40
Professional Viewpoints 42
New Materials and Parts 44
Calendar of Meetings 58
Topics 62
Manufacturers' Publications 64
Business Announcements 68

For Itemized Table of Contents See Page 7

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PRINCIPLES OF THE BALL BEARING

Load on a plain bearing is supported by a film of oil, the functioning of which is dependent upon such variable factors as film thickness permitted by bearing radial clearance and the effect of temperature changes upon lubricant viscosity. Maintenance of the oil film is influenced by other variables, such as speed of rotation, the method of lubricant supply, the design of oil-distributing grooves, and the changes in bearing clearance due to heat, as well as wear induced by sliding friction.

To secure m ...urate positioning of shafts and reduce the powe ...but in a manner not subject to t ...progres- sively changing ...ollers, first of cylind ...early employed.

Even in ...bearings possessed ver ...personal transportatic ...portance hitherto not ...became a matter of ir ...proved a necessity.

Just ...ke became synonymo ...s experience with the ... the present day form ... double row type) be: ...d lubricated- for-life ...

Wh ...ll bearing are Americ ...k, financed by the Deuts ...ne by research the fundamental pr ...e modern ball bearing. These principles were ... by Conrad in designing the single row annular or radial ba ...nd by New Departure engineers in their development of the double purpose, combined radial and thrust ball bearing.

— *in short*

The performance of New Departure Ball Bearings is *accurately predictable*

The ball bearing has, therefore, been distinguished from other forms of rolling bearings, in having a sound background of scientific principle governing its design. The resultant load-carrying capacity has thus not been merely a matter of experiment, but is subject to as accurate a mathematical determination as is the strength of a steel bridge. Though, compared with the plain bearing, the ball bearing is a mere infant in age, its load-carrying ability, endurance life and friction loss is predictable with infinitely greater accuracy and assurance than that of any other form of shaft support.

The steel ball, due to its shape, possesses inherent advantages not equalled in any other form of rolling body, in that whatever the angle

Itemized Index

CLASSIFIED FOR CONVENIENCE WHEN STUDYING SPECIFIC DESIGN PROBLEMS

KEY: EDIT., EDITORIAL PAGES; ADV., ADVERTISING PAGES; R, RIGHT-HAND COLUMN; L, LEFT-HAND COLUMN

Design Calculations:

Stresses, thermal, added information, Edit. 42

Design Problems:

Appearance, aided by illusions, Edit. 23
Electronic controls, specifying, Edit. 38-S(R)
Flame hardening, in parts, Edit. 30
Gas range, controlled by valve, Edit. 28L
Gears, couplings, nonmetallic, Edit. 48-S(R)
Hydraulics, in modern machines, Edit. 28-S
Lift, telescoping, how driven, Edit. 35, 36, 37
Mixer, conveyor principles in, Edit. 29L
Motors, shell-type, when to build in, Edit. 24-S
Noise, reduction of, Edit. 32-S
Plastics, combining with metals, Edit. 31
Screw machine, attaining speed, power, flexibility in, Edit. 21-S, 22-S, 23-S

Materials:

Alloys (aluminum), Edit. 44-S(R)
Alloys (copper), Adv. 21
Alloys (nickel), Adv. 45
Alloys (steel), Edit. 22-S, 23-S
Aluminum, Edit. 35
Brass, Edit. 32R, 44-S(R)
Bronze, Adv. 73
Copper, Edit. 32R
Plastics, Edit. 31, 32, 33, 34, 34-S(L), 48-S(R), 50-S(R), 52-S(R), 56-S(R); Adv. 8, 55
Rubber, Edit. 34-S(R)
Steel, Adv. 59, 63
Zinc, Adv. 18

Mechanisms:

Clutch, Edit. 22-S, 33-S(L), 66-S(R)
Driving, Edit. 22-S, 23-S, 24-S, 25-S, 26-S, 27-S, 32-S, 33-S, 34-S, 58-S(R), 60-S(R), 62-S(R)
Feeding, Edit. 22-S, 23-S
Hydraulic, Edit. 28-S, 29-S, 30-S, 31-S, 62-S(R)
Indexing, Edit. 22-S(R), 23-S(L)

Organization and Equipment:

Engineering department, Edit. 56R; Adv. 15, 44L, 48L, 54L, 55-S, 62L, 70

Parts:

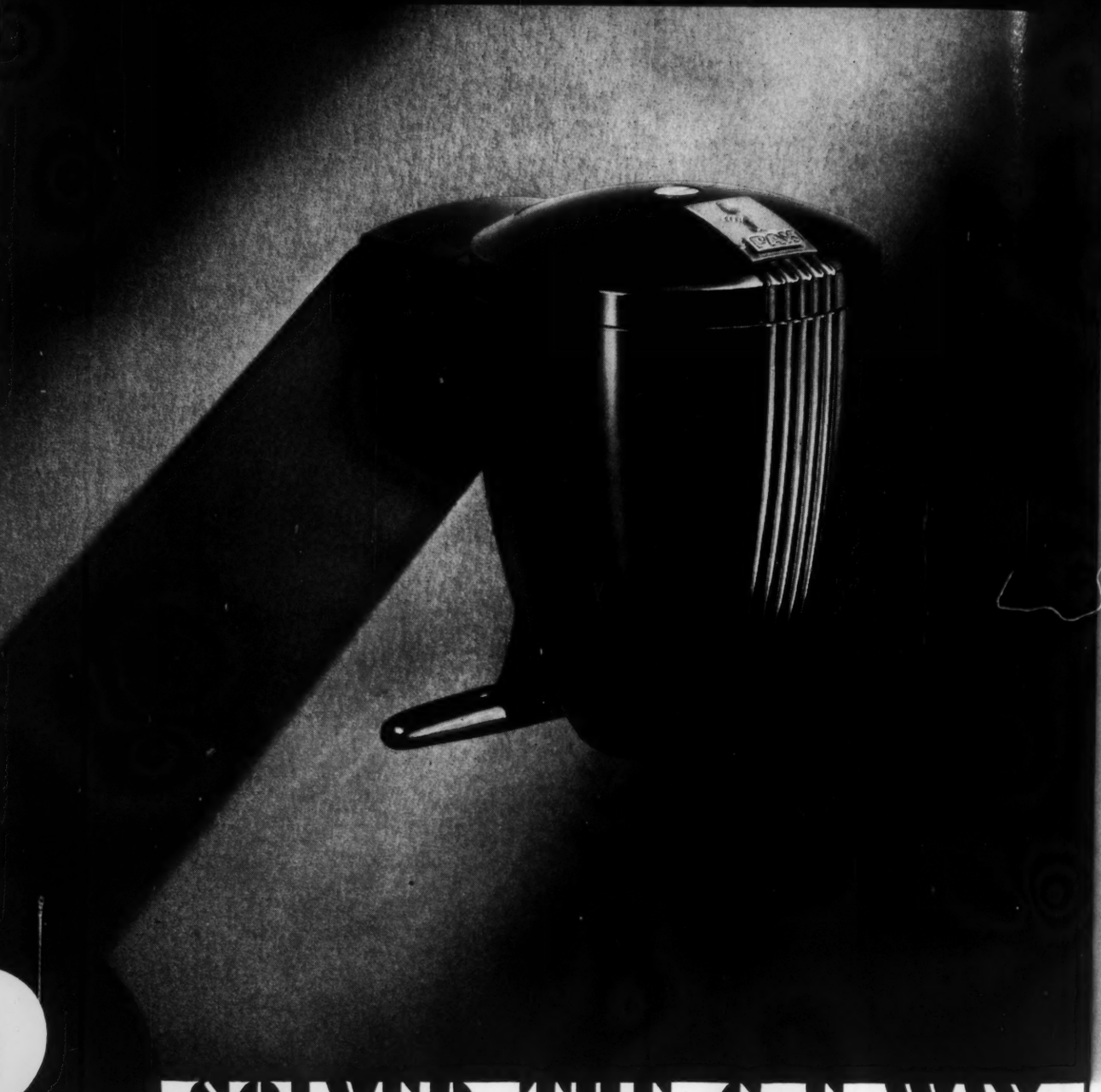
Bearings, Edit. 22-S, 23-S, 26-S(R), 54R; Adv. 6, 10, 11, 19, 43, 47, 50L, 57, 61, 65, 69, 73, 76
Bellows (metallic), Adv. 69-S(L)
Belts, Edit. 21-S, 33-S(R), 40-S(R), 66-S(R), 68-S(R); Adv. 72-S(L), 74-S
Cast parts, Adv. 18, 59
Chains, Edit. 22-S, 23-S, 33-S(R), 35, 36, 37; Adv. 2-S, 10-S, 17, 18-S, 41-S, 47-S, 55-S, 61-S(R), 69-S(L)
Clutches, Edit. 22-S, 33-S(L), 66-S(R); Adv. 49-S, 66-S(L)
Controllers, Adv. 46L
Controls (electrical), Edit, 23-S, 35-S, 38-S 40-S(R), 42-S(R), 44-S(R), 48R, 50R, 52R, 62-S(R); Adv. 2, 6-S, 14-S, 15-S, 16-S, 50-S(L), 53-S, 54-S, 58-S, 65-S(R)
Controls (electronic), Edit. 38-S, 52R
Controls (solenoid), Edit. 38-S, 42-S(R)
Counters, Adv. 41
Couplings, Edit. 48-S(R), 50-S(R), 52R, Adv. 60-S, 63-S(L), 67-S(L)
Drives, Edit. 46R; Adv. 4-S, 22, 39-S, 74-S
Engines, Adv. 61-S(L)
Fastenings, Edit. 29L; Adv. 3, 14, 20, 51, 54L, 67, 68
Filters, Adv. 9
Gears, Edit. 22-S, 23-S, 33-S(R), 36, 48-S(R), 50-S(R), 52-S(R), 56-S(R); Adv. 4-S, 19-S, 45-S, 46-S, 57-S, 59-S, 68-S, 70-S(R)
Hose (flexible), Adv. 49, 64L
Hydraulic equipment, Edit. 44R; Adv. 12, 13, 20-S, 43-S, 59-S, 63-S(R), 71-S(R), 73-S
Joints, Adv. 66L
Lubrication and lubricating equipment, Edit. 22-S, 29R, 29-S, 50-S(R); Adv. 9-S, 53, 58L
Motors (see also under Drives), Edit. 21-S, 23-S, 24-S, 25-S, 26-S, 27-S, 28-S, 28L, 34-S(L), 36, 37, 48R, 50R, 54R, 60-S(R), 64-S(R), 66-S(R), 68-S(R); Adv. 7-S, 10-S, 14-S, 15-S, 17-S, 48-S, 50-S, 61-S(L), 67-S(L), 71-S(L)
Oil seals and packings, Adv. 4
Plastic moldings, Edit. 31, 32, 33; Adv. 52L, 58L
Pneumatic equipment, Edit. 44R, 44-S(R); Adv. 3-S, 40-S(L), 62-S(L)
Pulleys, Edit. 54R; Adv. 44-S(L)
Pumps, Edit. 29-S, 44R; Adv. 52L, 52-S, 60, 62L, 64L, 66L
Shims, Adv. 71
Speed Reducers, Edit. 68-S(R); Adv. 42-S(R), 46-S, 56-S, 67-S(R), 68-S, 69-S(R)
Springs, Adv. 16
Valves, Edit. 28-S(R), 28L, 30-S, 31-S; Adv. 40-S(L), 52-S
Variable speed transmissions, Edit. 22-S, 23-S; Adv. 12-S, 13-S, 22, 39-S, 44-S(L), 65-S(L)
Welding parts and equipment, Adv. 74
Wire, Adv. 56R

Principles:

Hydraulic, Edit. 28-S, 29-S, 30-S, 31-S, 32-S

PLASTICS PROBLEM NO.

2

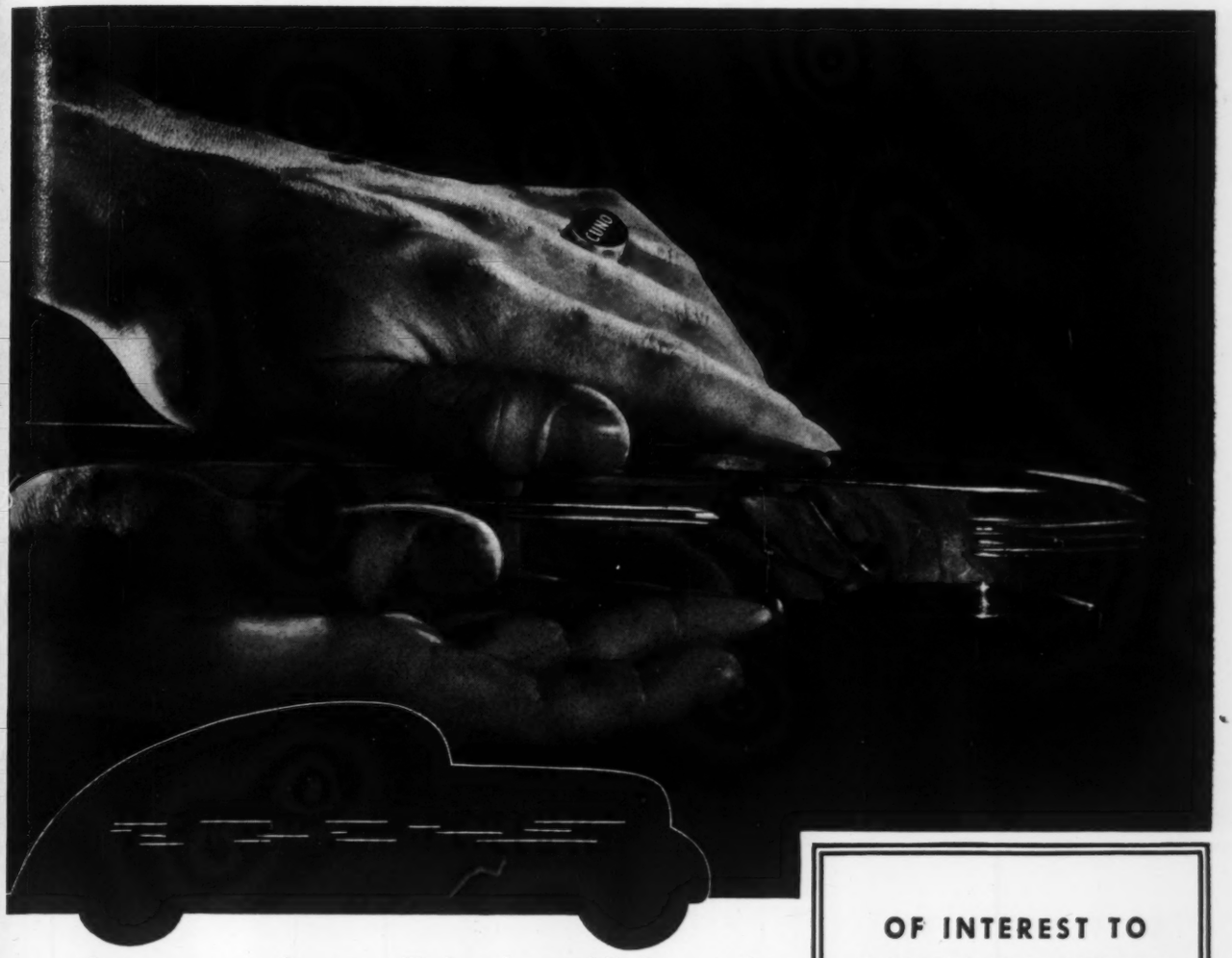


SOLVED THE G-E WAY

PARTS: Textolite Soap Dispenser Assembly. **USE OF PARTS:** This Textolite soap dispenser assembly consisting of five parts—main body, dispensing lever, cover, nameplate, and mounting bracket—is for the Pax Soap Dispenser manufactured by the G. H. Packwood Manufacturing Co., St. Louis, Mo. **CUSTOMER'S PROBLEM:** A complete mechanical redesign of this product to provide minimum molding costs consistent with good functional design. **SOLVED THE G-E WAY:** With the co-operation and help of Mr. G. H. Packwood, Jr., G-E engineers transformed the original dispenser design into a sturdier, more attractive product, mechanically sound and economical to mold. For instance, General Electric suggested a change in the mounting bracket from a round contour to its final shape to assure better moldability; while a change in the lever mechanism reduced mold costs and improved operation. Other small but important improvements, such as the captive cover that cannot be dropped and the method of affixing the nameplate, also contributed to minimum molding costs consistent with good functional design for the Packwood Company. Such engineering and designing co-operation, combined with General Electric ability and molding facilities, make THE G-E WAY your most dependable source of supply for plastics in molded, laminated, or cold-molded forms. Let us help you with your plastic requirements. For complete information and recommendations, on any product, write Section M-49, Plastics Department, General Electric Company, One Plastics Avenue, Pittsfield, Mass.

PD-291A

GENERAL ELECTRIC



In more ways than one. Today the world's largest tire companies use Cuno *continuously cleanable* filters for continuous protection against damaging solids found in water used to cure tires. And the bearings on which today's cars roll are pre-packed with Cuno-filtered grease.

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OF INTEREST TO DESIGN ENGINEERS

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264 South Vine Street
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Company..... City..... State.....

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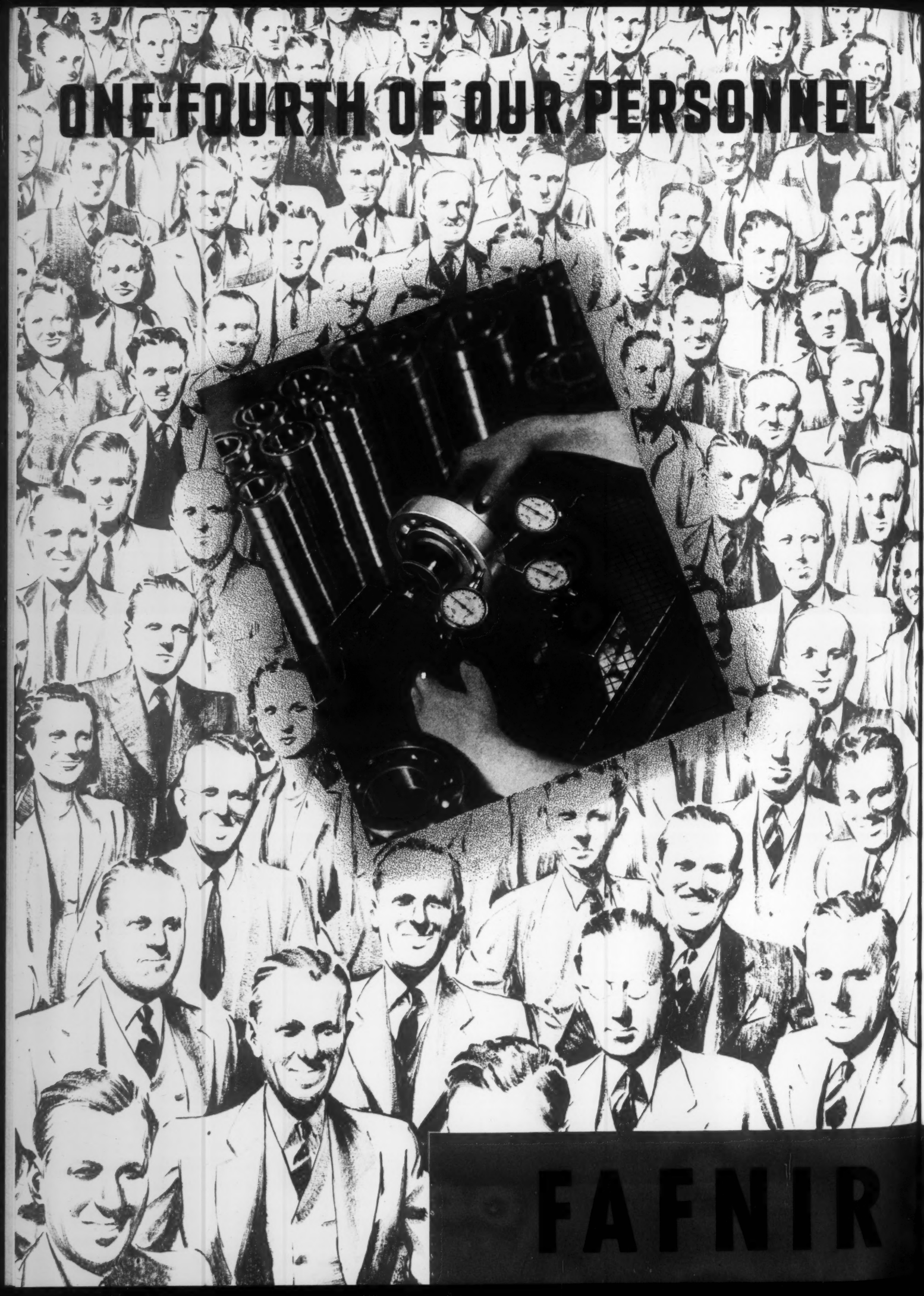
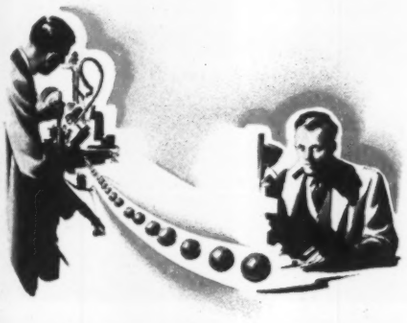
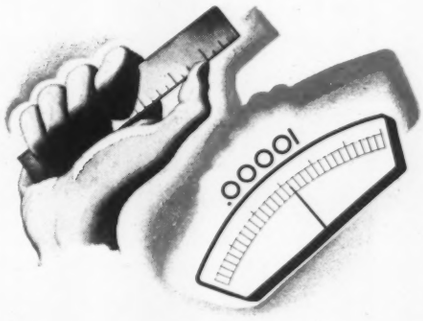

ONE-FOURTH OF OUR PERSONNEL
FAFNIR

Is Authorized to say "No!"

Fafnir's personnel, like that of most other manufacturing plants, breaks down into production units varying in size from one man to half a hundred. Each unit is responsible for a given step in production . . . each is highly trained to carry out its production orders to the letter . . . to answer "Yes"! and *produce*, no matter how intricate the problem . . .

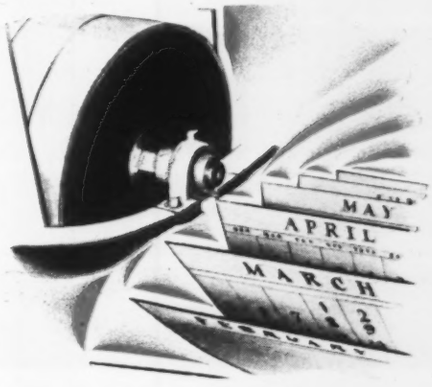


But there is another group whose highest duty is often to say "No!". They are Fafnir inspectors . . . comprising more than a fourth of our personnel. They know that it is not unusual for heavy investments in time and machinery to be dependent upon the close tolerances and tireless functioning of a ball bearing somewhere deep within a machine. That is why, for every production unit, Fafnir has set up an inspection unit . . . why, from original steel selection to final test, inspection governs every step of Fafnir production.



Much of Fafnir's inspection is on a plane of high precision far beyond the scope of human eyes and hands. So Fafnir has adapted laboratory-accurate methods to routine work, utilizing the "eyes" and "hands" of electricity, of magnetism, of instruments that "feel" hundred thousandths as your fingers feel inches. Thus, the possibility of human error is virtually eliminated.

Look at a Fafnir Ball Bearing beside any one of a dozen other makes. You can't see that its rings are forged from carefully-selected bars of specially developed steel. That balls and races have been ground to maintain ten-thousandth uniformity. You can't see the benefits of Fafnir machining and hardening, of countless Fafnir inspections.



But after those ball bearings have made their millionth revolution, you'll thank the Fafnir Bearing for continued accuracy of alignment, for new machine efficiency, for negligible maintenance required throughout its long life. The Fafnir Bearing Co., New Britain, Conn.

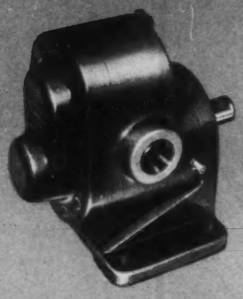
BALANCE IN DESIGN

In ball bearing design, ball size, race depth and ring thickness determine life and capacity. Fafnir's larger balls carry greater load; make fewer revolutions per bearing revolution, with resultant longer life. Fafnir's deeper races also increase load capacity, and provide thrust capacity to a degree unusual in a radial bearing.

Every Fafnir Ball Bearing has been developed to the point where high capacity and long life are inherent attributes of a perfectly balanced design.

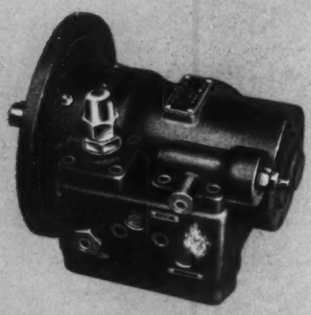
Ball Bearings

THE BALANCED LINE . . .
MOST COMPLETE IN AMERICA



VICKERS Balanced Gear Fluid Motor provides efficient and compact variable speed rotary drives. Available in wide range of sizes.

VICKERS Balanced Vane Type Pump for continuous working pressures up to 1,000 lb. per sq. in. Extremely quiet in operation.



VICKERS Double Pump and Combination Valve Assembly delivers large volume at low pressure and relatively small volume at high pressure. Quiet.

VICKERS Electric-Hydraulic "Traverse and Feed" Panels are available in several types and sizes. Only two moving parts—no latches or linkage.

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Your hydraulic drive and control problems will have the benefit of the experience gained by Vickers engineers in developing thousands of applications, the following being representative:

MACHINE TOOLS
"Feed and traverse" cycles, reciprocating cycles, indexing drives, spindle drives, unit head installations, clamping and chucking, clutch control.

SPECIAL PURPOSE AUTOMATIC MACHINERY
Applications so varied that each is a hydraulic control problem entirely its own, utilizing standardized Vickers Controls of all types.

PLASTIC INJECTION AND DIE CASTING MACHINERY
Controls for die operation and material injection . . . either manual or automatic cycles with safety interlock features.

PRINTING MACHINERY
Tension and impression controls, matrix press operation, variable speed press drives, handling equipment.

HYDRAULIC PRESSES
Controls for forming, coining, drawing, piercing, riveting, straightening and bending operations . . . variable and constant delivery high pressure installations for small or large work.

STEEL MILL EQUIPMENT
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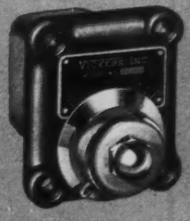
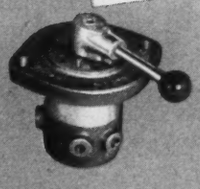
WELDERS
Work clamping, and operation of spot, projection, butt and seam welding cycles.

AVIATION CONTROL DEVICES
Light weight pumps, fluid motors and hydraulic control units for varied aeronautical applications.

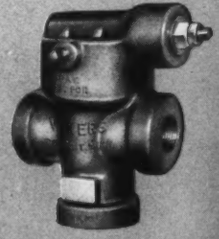


VICKERS Flow Control Valve provides positively controlled rate of flow not affected by changes in operating pressure or work resistance; also has temperature compensation.



A complete line of manually and mechanically operated Vickers Pilot Valves is available.

VICKERS 3-, 4-, 5- and 6-Way Valves are available with many modifications including manual, latch, pilot or solenoid operation.



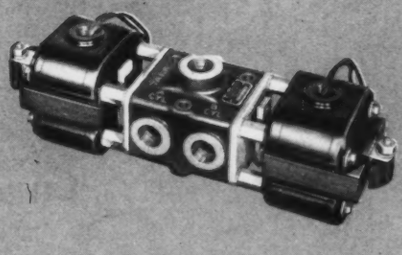
VICKERS Hydraulic Relief Valve (Balanced) for various pressure and capacity ranges. Smooth and quiet in operation.

VICKERS
HYDRAULIC CONTROLS AND DRIVES

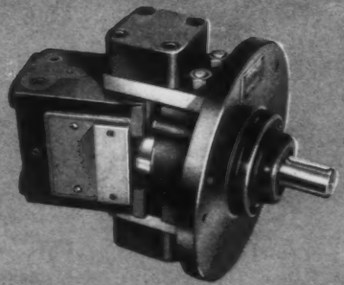
It is no accident that so many of the really modern production machines are equipped with Vickers Hydraulic Controls and Drives. Designers everywhere have found Vickers equipment the best answer to a host of such control and drive problems. • The most complex controls and motions are secured with relative simplicity. Any required thrust at any given point and any practicable speed of movement are easily secured. Using oil as the working fluid, operation is smooth and positive, while the machine is protected against overload and the control self-lubricated. • Vickers engineering enterprise and research have developed a number of advantages available only in Vickers equipment. Vickers Hydraulic Engineers will gladly explain how these can be used profitably in your designs.

VICKERS *Incorporated* • 1430 OAKMAN BLVD., DETROIT, MICH.

VICKERS Hydraulic Variable Speed Transmission, used for wide variety of rotary drives. Integrally built controls for every need.



VICKERS Solenoid Operated Valves provide direct electrical control, where required, for oil hydraulic systems.



VICKERS Variable Volume Pumps of multi-cylinder type available in various capacities and maximum operating pressures up to 2,500 lb. per sq. in.

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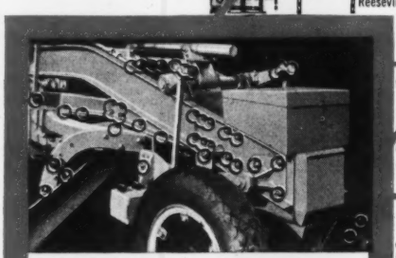

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Controls MUST be kept tight and aligned! No other locking method CAN do the job like Helical Spring Washers!

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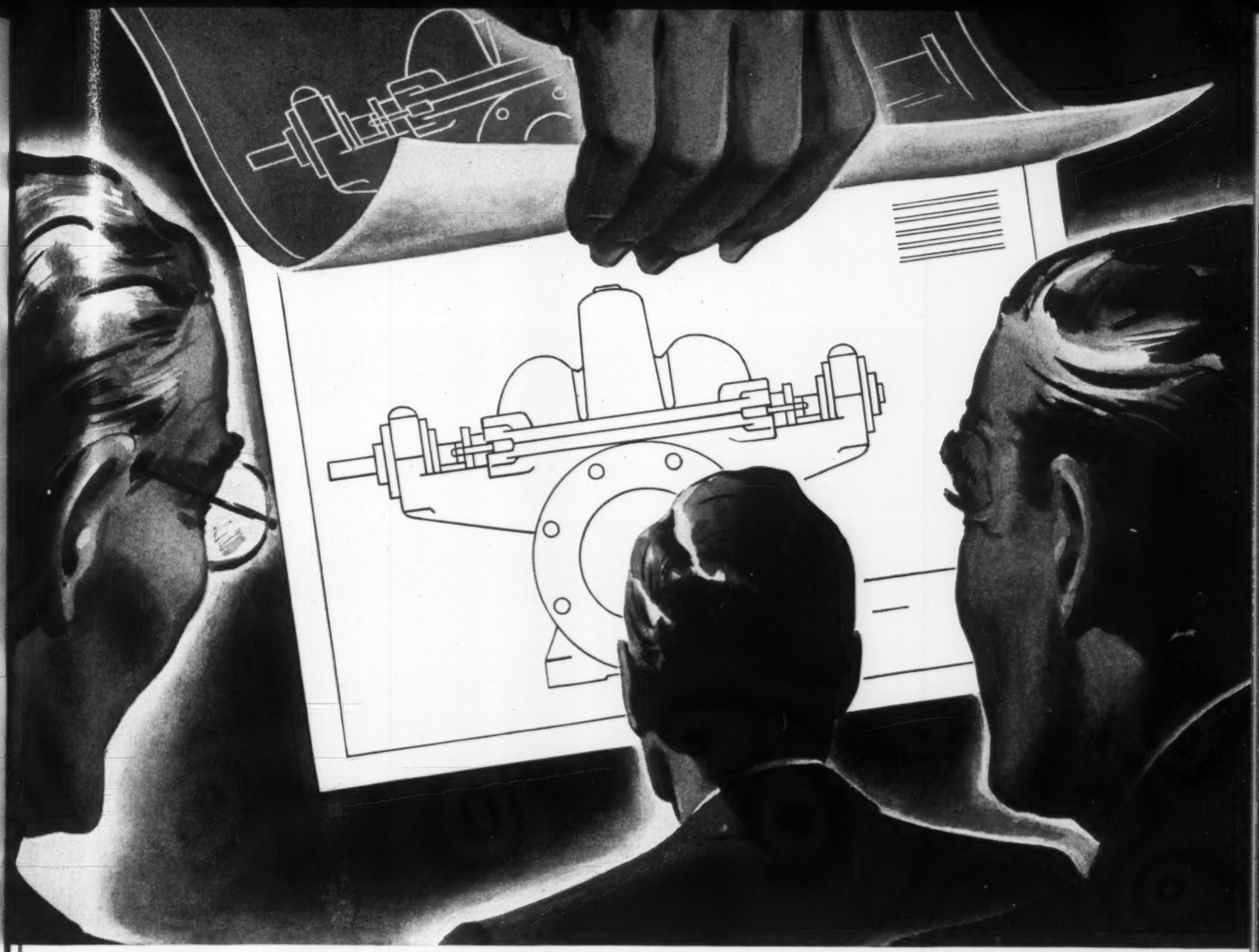

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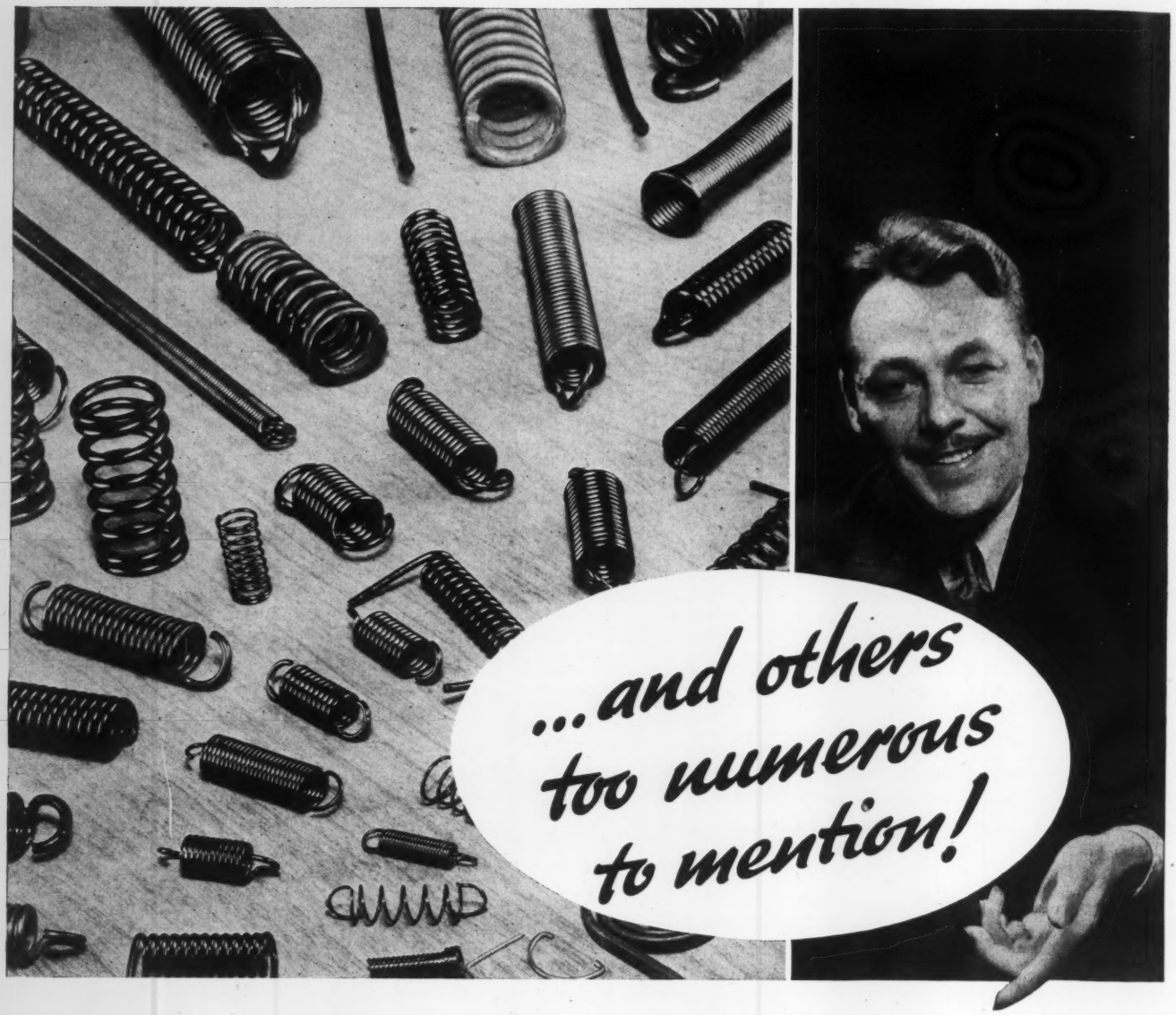

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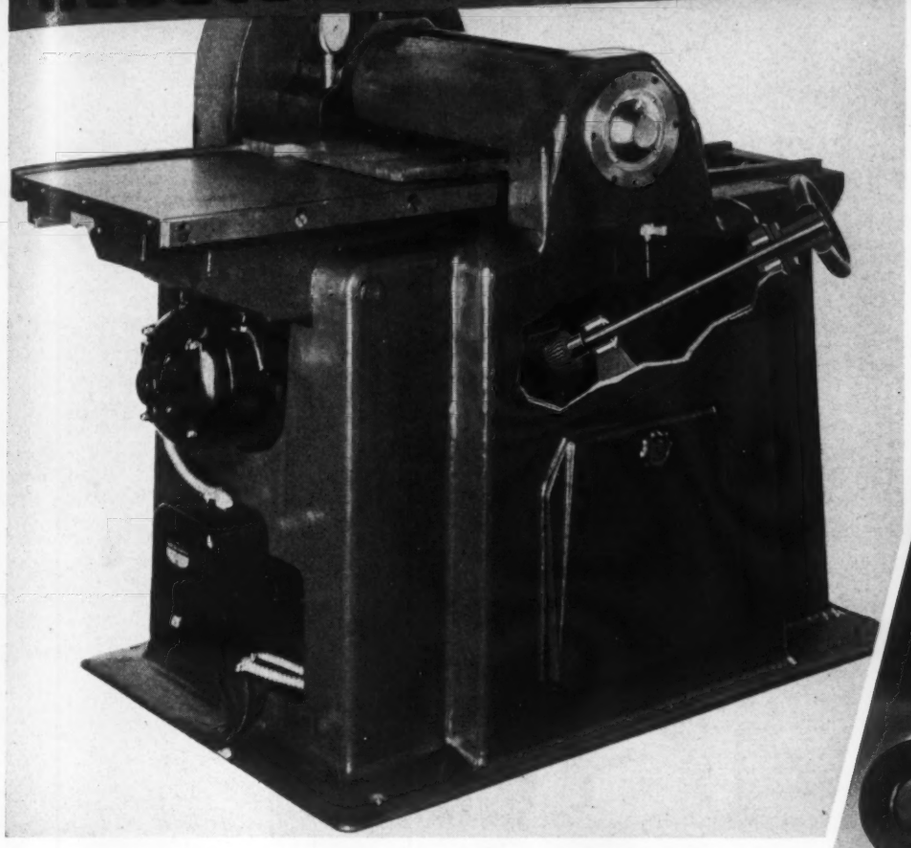
MACHINE BUILDERS AND DIEMAKERS REDUCE COSTS WITH CERROMATRIX



Photograph courtesy of Hess & Barker, Engineers and Machinists, Philadelphia, Pa.

Photograph courtesy of Motor State Products Co., Ypsilanti, Mich.

In the Hess and Barker Rotary Shaver for electrotype plates shown here, an intricate problem in machine design was presented in locating the bearings for the hand-wheel controlled shaft used for raising and lowering the table. The peculiar angle at which it is necessary for the shaft to operate makes it a long-drawn-out job to locate the bearings accurately in the collar and bracket, if ordinary methods are employed.

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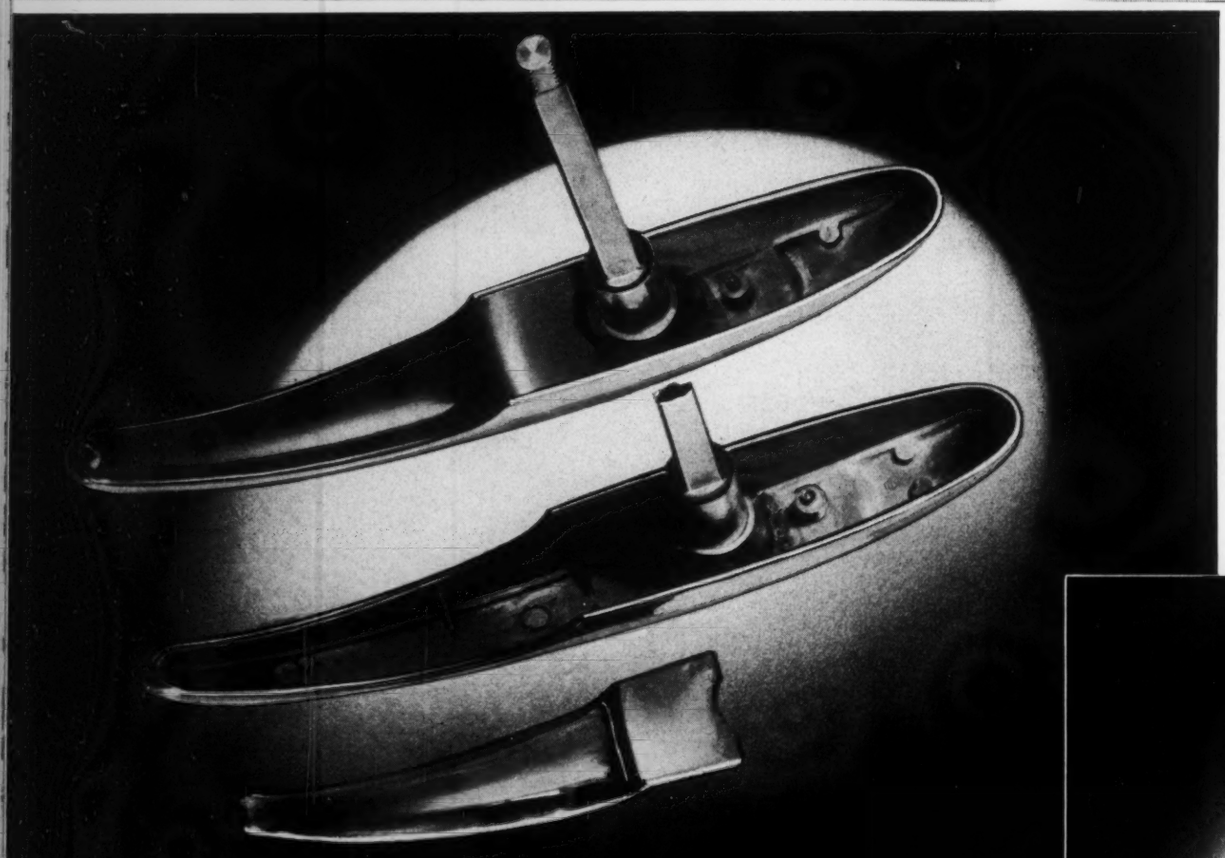

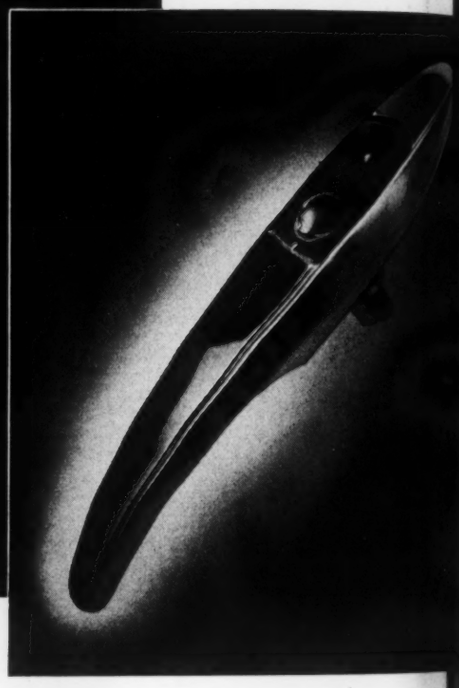

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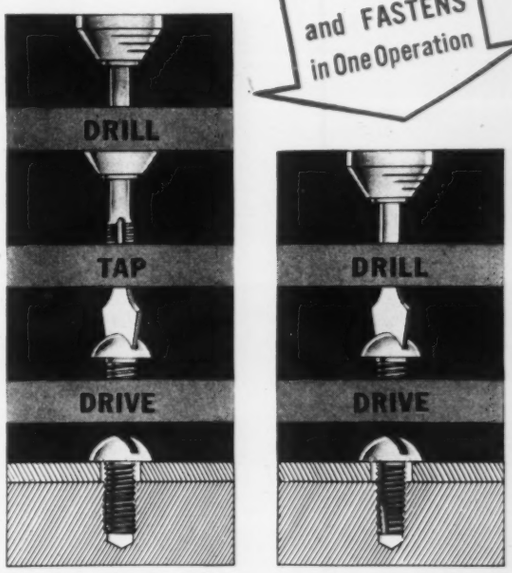

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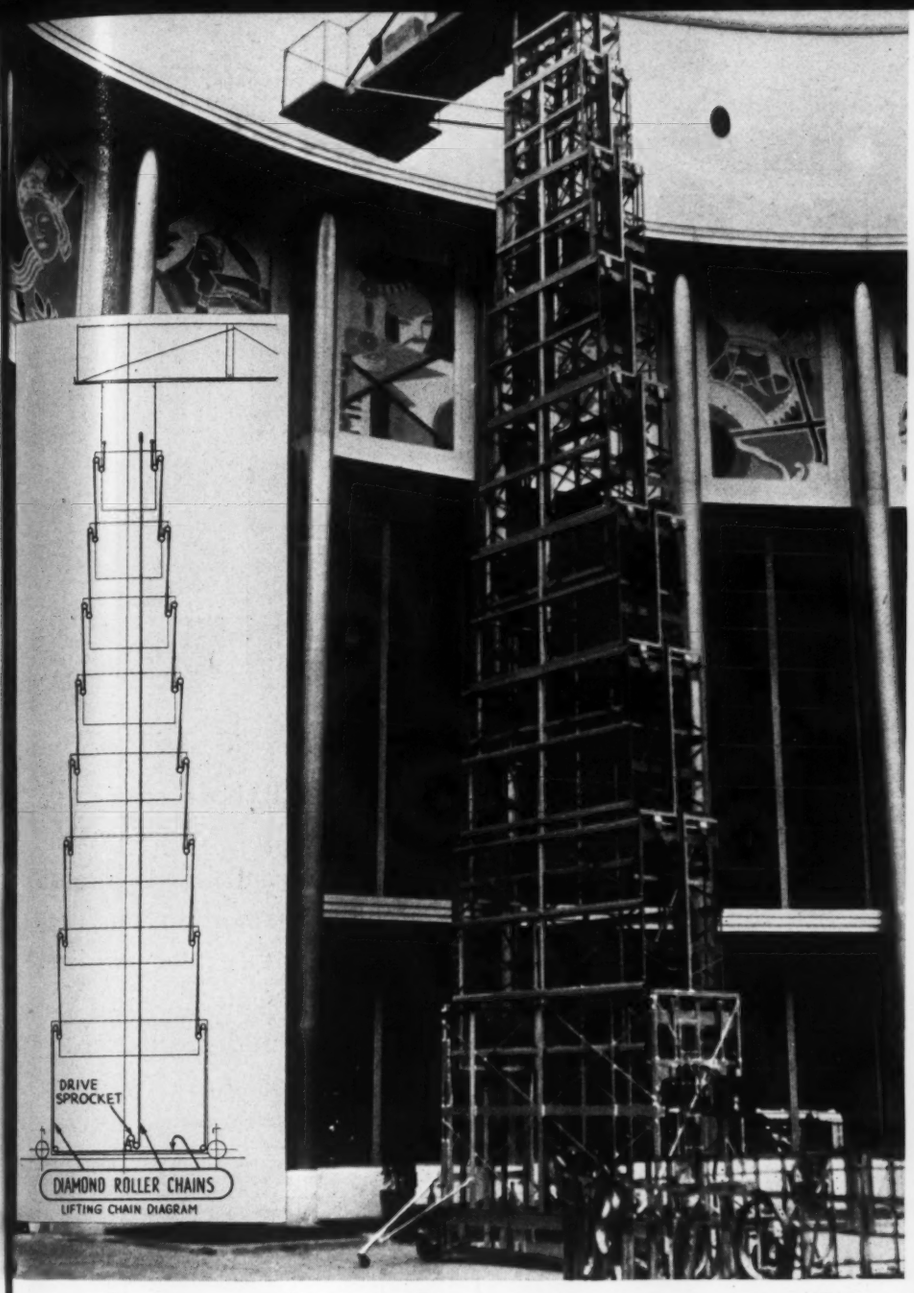

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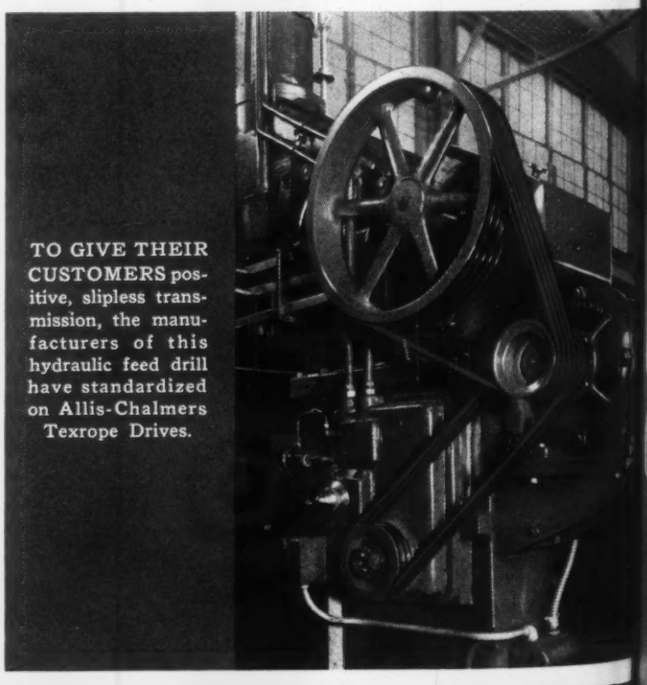

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MACHINE DESIGN

Illusions Aid Appearance

By Harold Van Doren*
Harold Van Doren & Associates

STYLING is the art of using lines, forms and colors to arouse an emotional reaction in the beholder. Whether the reaction evoked is the genuine thrill communicated by an object of great intrinsic beauty, or merely the desire of possession, is beside the point. The designer fails only when the beholder is displeased or remains completely indifferent.

Effective styling cannot be accomplished without emotion, and it will not be communicated to others unless it is present in the designer during the act of creation. No amount of theory, used cold-bloodedly without accompanying creative enthusiasm, will produce successful design.

Every art, however, has its technique. There are certain effects developed over the centuries which, because they are derived from universally apprehended phenomena, have become the stock-in-trade of all subsequent designers. They are analogous to the follow-through of a tennis stroke, or relaxed arm weight in playing the piano. If one knows them they become almost subconscious and produce a certain premeditated result. Once these effects are understood, they may be used quite independently of the emotional phase of the creative process. And they will often add subtlety and refinement—the finishing touch which may save a design from mediocrity.

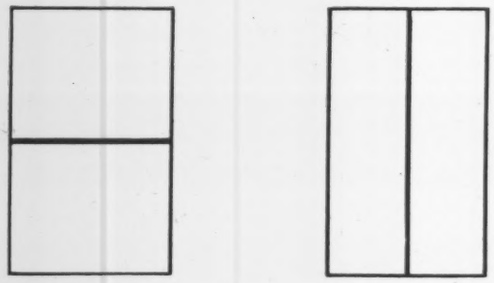
The principles which have been referred to stem mostly from cer-

* Mr. Van Doren is author of a forthcoming book on styling to be published by McGraw-Hill Book Co. One of the chapters of the book will be based upon material similar to that contained in the contribution which appears on this and the following pages

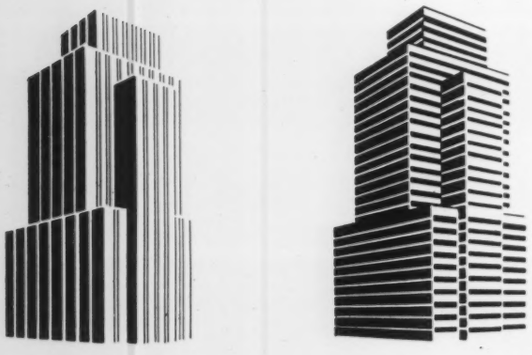
tain optical phenomena experienced by people with normal vision. If the designer is aware of them and knows when they should be used, he will be able better to make the beholder's eye do his bidding. In the design field the basic shape is more often than not awkward and difficult. A given rectangle may be too long to be a pleasing or easily divided shape, and yet not long enough to become a mere *band*. On the other hand it may approach too closely to a square to be agreeable.

Effects of Space Division

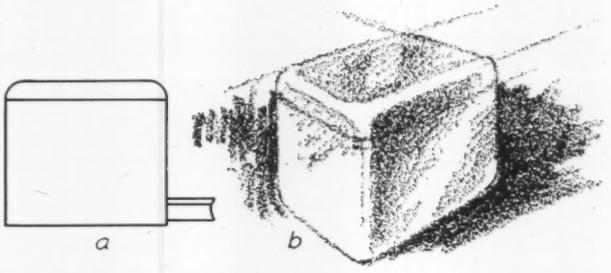
Limitations of space and mechanical considerations may make this particular rectangle impossible to change. If such is the case, the designer has at his command certain resources to trick the eye into seeing the shape as a form which it is not. One of these resources may be demonstrated, in the manner of an "optical illusion," by dividing two identical rectangles with lines in opposite directions, thus making them appear quite different shapes:



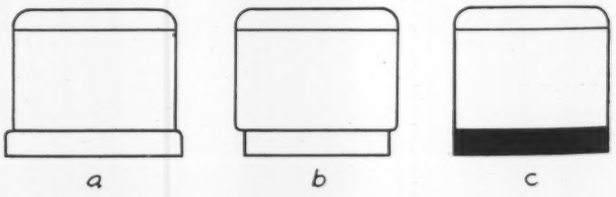
It is the same trick used by skyscraper architects, who emphasize still further the verticality of their tall spires by using reveals continued vertically between bands of windows. More recent architectural thinking considers it dishonest, because a skyscraper is merely a succession of horizontal floor arches one on top of another. The tendency today is to emphasize the horizontal window-bands at each floor, or at least to let them be what they are—just windows. Regardless of which is architecturally more sound, the latter treatment makes a building look shorter:



A domestic furnace stoker will demonstrate this simple principle. The manufacturer wishes to enclose the device with its hopper, motor, reducing gears and feed worm in a simple and inexpensive sheet-metal housing with hinged cover. Dimensions of hopper and other parts to be enclosed are such that the rectangle formed by the side elevation of the housing is not quite a square. Various ways to elongate this undistinguished form are tried, but the length cannot be decreased without reducing hopper capacity, or increased without housing too much "air". The side elevation and a first rough perspective layout are illustrated in the following diagrams at *a* and *b* and show the general shape the final enclosure should have:

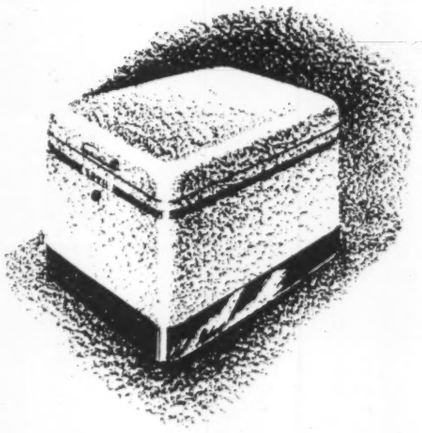


Due to comparatively small sales volume in this particular item, investment in dies is warranted only for forming the top cover; the rest of the housing must be fabricated. Various possible methods of making this awkward rectangle more pleasing are shown below: *a* introduces horizontal lines by "revealing" a band around the bottom; *b* accomplishes the same result somewhat better by recessing the base; *c* does the same by the simpler means of a change in color—merely applying a painted black band. Both *a* and *b* increase the cost; *c* is therefore adopted, although it is not quite as effective a solution as *b*.



When the design is nearing completion, a decision is reached to embellish it further by the addition of another horizontal stripe above, in a deeper value of the body color, and make this stripe continuous across the front with the company name. A cover handle is added, and the company trademark spotted agreeably in relation to the stripe, not too close to inter-

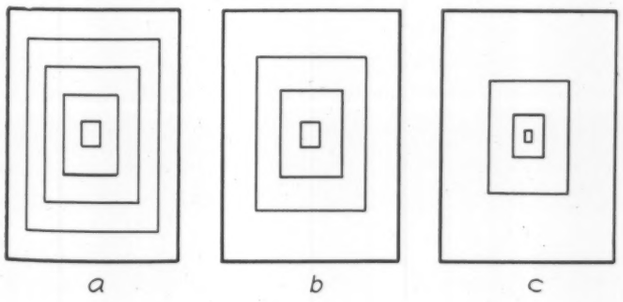
fere with reading, not too far away to appear isolated. This illustration shows the result:



Another simple optical fact is that a square within a square or a rectangle within a similar rectangle, if placed geometrically in the center, will appear to be below center. Therefore we should always place the inner panel somewhat above center—how much above is a matter for experiment in each individual case.

The reason for this is not easy to discover. Perhaps it is because the eye has a tendency to "read upwards" in looking at any object, and unless the inner panel is above center it will *appear* to be below. At all events, it is a simple rule to remember, and one of the ABC's of styling.

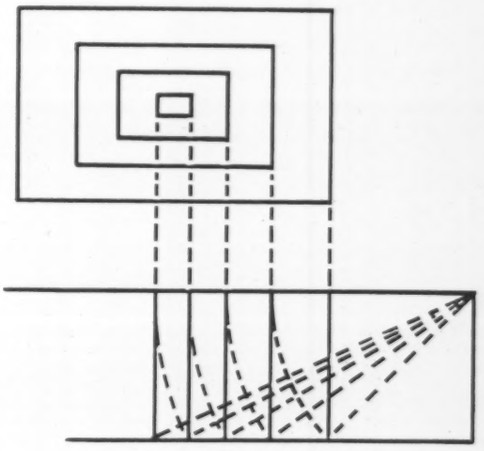
If we are dealing with a series of diminishing squares or rectangles one within the other we shall find that even spacing of the elements (*a*, below) is less interesting than progressive spacing, *b*. Progressive spacing seems to give the feeling of growth; even spacing remains static. But what rule will give us the desirable *amount* of progression? If the eye is well trained one can experiment until it looks right, but some may feel the need for mechanical aid. The geometrical progression where each increment doubles the preceding increases too rapidly, *c*.



There is, however, another kind of dynamic progression which always gives a sense of satisfaction to the eye. It is based on "root rectangles." Beginning with a square, lay out a series of rectangles each of which is based on the diagonal of the preceding one. Go as far as you care to, then start on any point, working backward, to obtain the increments from the center of the square or rectangle, as shown in the illustration below.

There is an artifice, known to the Greeks as "entasis" (a stretching), which has become of considerable importance in the design of machines and products. Its most obvious use is in columns—the slight swelling reaching a maximum somewhat below center.

The actual application of entasis to vertical designs would be difficult, for few products or even machines are tall enough to make the device of particular value. We would be checkmated, too, by the materials used in industry or the particular process of manufacture employed. Entasis would be impossible, for instance, in working with sheet metal fabricated on brakes; it would be difficult and costly in stampings. It is a possibility in the casting or plastic molding processes, but would be of little value unless the item were of considerable size.



There are analogous curvatures or swellings, which, due to the popular trend away from sharp and "edgey" metal forms, and the substitution of large soft radii at corners and edges have become more and more important. Every designer now knows that, unless he employs them, or some similar trick, plain sheet-metal surfaces will be likely to have a "dished" appearance. The cure for this is to give the flat surface a slight outward swelling—very slight—just enough to overcome the optical illusion of concavity.

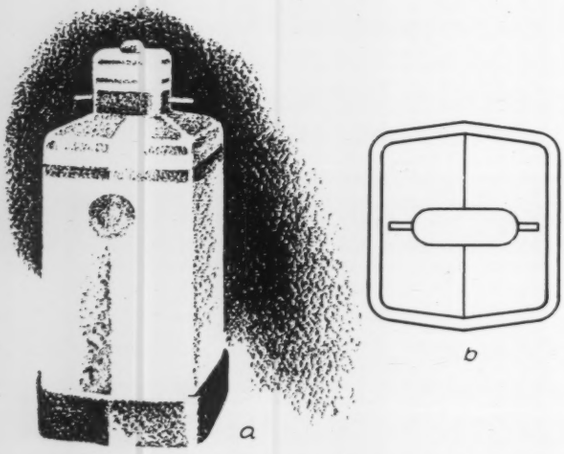
Convex Sides Appear Flat

This method is useful in the design of refrigerators, water heater housings, ironers and a host of other machines where stampings are employed. It has a practical value too, for it tends to stiffen a

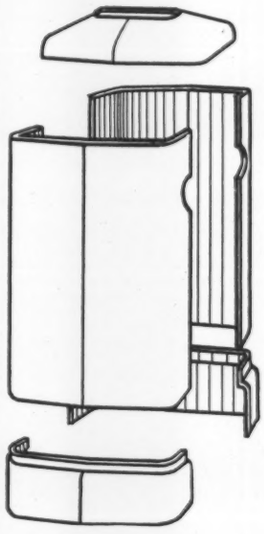
stamping, preventing the flat area of metal from snapping in and out when touched—commonly called the diaphragm or "oil can" effect. The designer will often increase the swelling, of course, to the point where it becomes noticeably bulged, witness most refrigerator doors. This is entirely legitimate if it is the effect desired, but it ceases to be analogous to entasis, or camber.

If Forming Methods Are Limited

When curvatures are not practical because of die cost there are substitute devices that may sometimes be employed. If used with discrimination a flat surface may be peaked in the center between corner radii. Some designers in fact use this effect so frequently that it has become almost a trademark of their work. Let us take a service station lubricating machine to illustrate. The unit consists of a square dolly with four casters on which a drum of grease is placed. Over this, concealing both drum and dolly and supported by the latter, is placed a sheet-metal cabinet, consisting of an offset base enameled black, two bent sheets lock-seamed to form the body, and a cover stamping on which is mounted the pump mechanism and to which are attached air and grease hoses. A long tube attached to the pump extends downward almost to the bottom of the drum and compressed air forces the grease through the hose and out through the gun. Here is shown the finished unit, *a*, and a plan view, *b*.

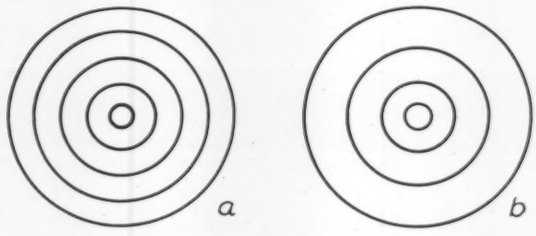


For the sake of economy the cabinet must be made, if possible, with few dies. The cover only will be a stamping; the base will be formed on bending machines and a small radius put in the upper edge with rolls; the body of the cabinet will be fabricated on brakes; the pump housing will be die castings. The cover being stamped out on a die, it will be a simple matter to form it with a slight peak front and back, which blends out a few inches back from the edge. To make the body of the cabinet conform to this shape, the cabinet is fabricated in two halves. After the vertical corner radii are formed on brakes each half is placed in a simple die and a peak formed down the center. Without this device, the cabinet, which



is practically square in plan view, would lack character. The division of planes created by the peak subtly vary the half-lights and high-lights and give variety to an otherwise monotonous plane. The separate parts involved in the design are shown above.

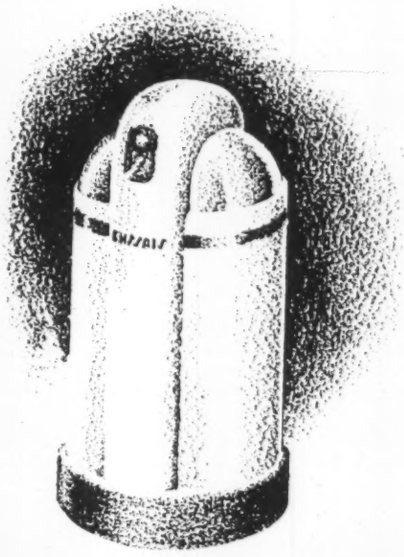
Concentric circles are subject to the same manipulation as the square-within-a-square mentioned earlier. A similar result is obtained by applying a dynamic versus a static effect:



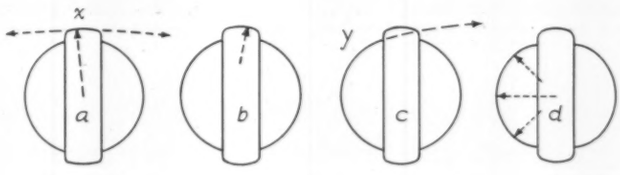
Cylindrical forms are difficult to manipulate successfully unless one is aware of some of the strange distortions that may occur if one sticks too closely to pure geometry. As illustration this time we shall use another lubricating unit, of more modern design. The trade clamors for "streamlined" equipment in which the pumping mechanism is completely concealed. This time we have chosen a cylindrical theme, and a discussion of the design follows. In order to conceal the pump and not make the cylinder too high, a dome is placed atop the cylinder to clear the pumping mechanism inside.

From the sketch it would seem to be plain sailing

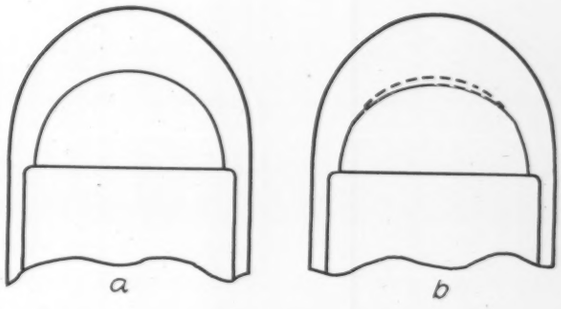
– nearly all perfect geometrical forms, except for the crest which is elliptical in side view. But such is



not the case, and as we proceed with scale models in clay we find that all is not well. In the next illustration, *a* shows a plan view treated geometrically, a perfect circle, intersected by a band having its two ends concentric with the main circle. When the study model is made to these dimensions these short arcs, *x*, do not *appear* concentric at all, but have the appearance of much larger arcs with a longer radius. To overcome this tendency for the eye to fly off into space we will have to reduce the length of the radius of arc *x*, making a considerably smaller arc not at all concentric with the main circle as at *b*. When this is done another optical illusion appears, for the arcs of the main circle, *y*, also appear to fly off at a tangent, as at *c*. To counteract this, we will have to make each of the partial sectors of the main circle compound curves, composed of three separate arcs, *d*.



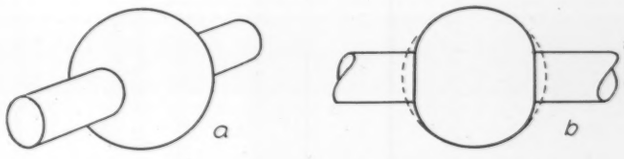
When this change is made in the clay model we discover that we have completely destroyed the dome-like hemisphere, because we have cut away part of it in order to alter the main cylinder of the unit. Furthermore another similar illusion to that mentioned above occurs in the case of the dome, if, in side elevation, we retain a segment of a perfect circle as shown. The interruption of the spherical form by the band, plus the "pull" of the elliptical line above it, leads the eye to believe that it is not a true sphere but a slightly pointed shape. Again we will have to correct this by flattening out the arc, producing another compound curve, *b*.



When we have finished we find that we have no purely geometrical forms left, although the general effect remains geometrical. The optical illusions have been overcome, and in the process the design has become more subtle and more alive.

At this point the cost-minded reader will object that the die expense involved in such a design would probably prove prohibitive. It obviously will involve more hand work to produce dies for these almost free-hand curvatures, than to proceed with the original cylinder-and-sphere design. To him I can only reply that this is a machine already in production, and that the refinements were insisted upon regardless of greater tool expense.

Designs involving a free-standing sphere may be equally perverse. As we have seen, the sphere is the most perfect and self-sufficient of all geometrical shapes. But it has a way, if truncated or penetrated by another form, of losing its character and tending to become either elliptical or flattened. To make it appear geometrical, it may be necessary to indulge in some modifications.



At *a* is a sphere penetrated by a cylinder. If the cylinder were much smaller in diameter than it is, the sphere would retain its shape without modification being necessary. But if the model were before you, in three dimensions, it would readily be seen that it looked slightly ellipsoidal, and corrections would have to be made, *b*.

These illustrations should serve to indicate some of the tricks that may be of practical value. Experiment and practice will reveal many more refinements. Best design practice has shown that mathematical regularity creates monotony. The lack of subtlety in much modern work has given it a deserved reputation for being cold and inhuman.

Scanning the Field FOR IDEAS

Automatic Pilot Lights Range

ELECTRIC ignition for gas ranges on turning a valve brings this type of fuel to the fully automatic stage. The unit shown in *Fig.* 1 also provides automatic shutoff for the gas supply should the pilot become extinguished. This initiates the ignition cycle, again relighting the pilot which in turn relights the burners. Thus the automatic device illustrated, designed by the Bryant Heater Co., fully protects the equipment it controls.

The design employs an ignition coil for igniting the pilot, a thermostatic element controlled by the pilot flame, and a gas valve and electric contacts operated by the thermostat. On turning the manual valve for lighting the burner, the electric circuit is closed,

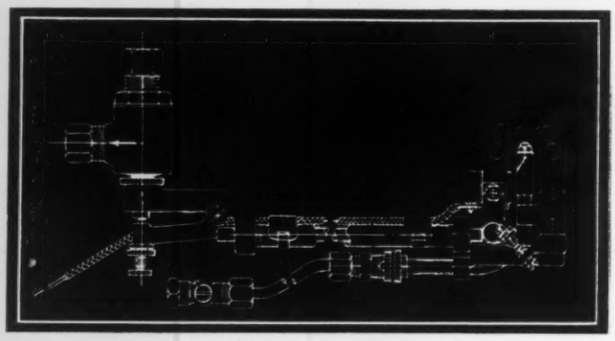


Fig. 1—Electric ignition provides pilot for gas burner with automatic feature

igniting the pilot which is fed by a by-pass supply around the automatic valve. This latter valve feeds the burners and is closed until opened by the thermostat. After a few seconds the flame expands the horseshoe thermostat, opening the electric contacts and the automatic valve. This completes the cycle and the burners light.

Should the pilot flame at any time become extinguished other than by closing the manual valve reignition will take place automatically. Cooling of the thermostatic element will close the automatic valve and re-energize the ignition coil by closing the electric contacts. Then the lighting cycle is repeated as discussed.

Operation of the parts is shown in the illustration. The thermostatic element is in the form of a horseshoe with a row of holes at its curved part so that when the portion within the row of holes is heated by the pilot flame, the horseshoe tends to open. One leg is rigidly mounted. The other, being movable, is responsive to pilot temperature. Motion of this leg controls the ignition coil and automatic burner valve. In its cooled position the coil contacts and valve are closed. In its heated position it opens the contacts and extends a pusher rod to operate the spring-closed valve.

Capacitor Motors Become Versatile

COMBINING the characteristics of six different types of motors into one design has recently been accomplished for fractional horsepower capacitor motors applicable to unit heaters. This advance in design is welcomed by motor users and may well forecast the possibility of achieving similar results for motors in heavier power applications.

Especially useful are such designs where machines are stocked with built-in drives. Reduction in stock and inventories possible for a full line are appreciable and fire the imagination regarding future reduction in costs of the final product.

Requirements for unit heaters involve seven sizes up to one-half horsepower with six types of motors—single-speed, two-speed and multispeed for both 110 and 220 volts. The new designs work equally well on either voltage and operate as single speed motors. Addition of a separate reactor in series with the line makes a two-speed motor. For multispeed service, a variable voltage controller is used.

Economics determine the limits of capacitor motor sizes. Recent improvements in capacitors make the extension of their sizes practical. Desirable for single phase applications because of high starting torques, high efficiencies, and high power factor, standard capacitor motors are now available in larger sizes. A recent installation of an unusually large capacitor

motor indicates future possibilities. This motor drives a compressor on a railway system and is rated at 40 horsepower, 25 cycles. The equivalent motor applied to 60-cycle power would be approximately 75 horsepower.

Division Principle Mixes Materials

SCREW conveyor principles have been applied to a recently designed mixing and blending machine for dry materials. Blending without dead spots or crushing of particles is accomplished in this mixer, developed by the Patterson Foundry & Machine Co., schematically illustrated in *Fig.* 2.

The drawing shows a blender arranged for discharge at the feed opening but discharge may also be arranged at the opposite end. In this way the blender serves a dual function of conveying as well as mixing. Division of material into thirds by geometric progression is accomplished by a screw and scoop arrangement as the cylinder revolves.

Material fed into the blender enters a single helicoid screw flight fastened to the outer shell for one third the length of the blender. At that point a double screw divides into two distinct streams. When a third compartment is reached, a triple screw flight effects division into thirds.

Each compartment of the outer cylinder is equipped with scoops which picks up one-third of the material and deposits it in the inner cylinder. Again it is divided into sections travelling backward toward the starting point the length of one compartment. One stream is permitted to return to the outer cylinder and a double stream carried through the second compartment. Another stream is dropped at the end of the second compartment and the third near the feed end of the machine.

Thread Insert Prevents Stripping

FOR USE in soft alloys such as magnesium or aluminum alloys where threads would be damaged by repeated assembly, a new type of thread insert has been developed. Suitable for application to stud bolts on airplane cylinders etc., these inserts provide strong threads and thus reduce the hazard of stripping. They are nonweaving and permit accurate control of thread tightness.

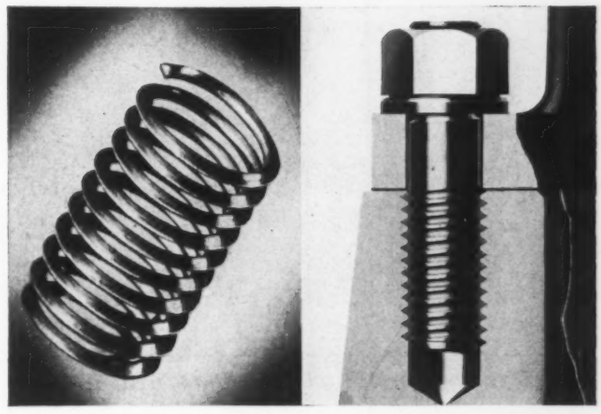


Fig. 3—Spiral thread insert protects threads from damage in soft materials, permit control of thread tightness

Precision formed, the inserts are spirally wound bronze spring wire. They fit into specially tapped holes in such a way that when installed they become a fixed part of the tapped hole. When a bolt is assembled, its threads bear against the insert instead of the softer metal. In *Fig.* 3 are shown a thread insert and a sectional view of a stud threaded into an insert.

Magnets Eliminate Shaft Bushings

PERMANENT magnets are being employed in fluid level indicating gages to eliminate the usual bushing and packing gland between the shaft and diaphragm. This new design precludes the possibility of leakage or shaft seizure at the bushing. Thus a more freely operating indicating mechanism is provided which requires no maintenance.

Affixed to the float and gear mechanism within the fluid tank is a permanent magnet which rotates on the axis of the indicating finger. On the shaft of the finger is a similar magnet which follows accurately any movement of the first magnet. Interposed between the two is a nonmagnetic diaphragm. In this way there is no mechanical connection between the inside and outside of the gage. Only one gasket is required where the unit is rigidly mounted on the tank.

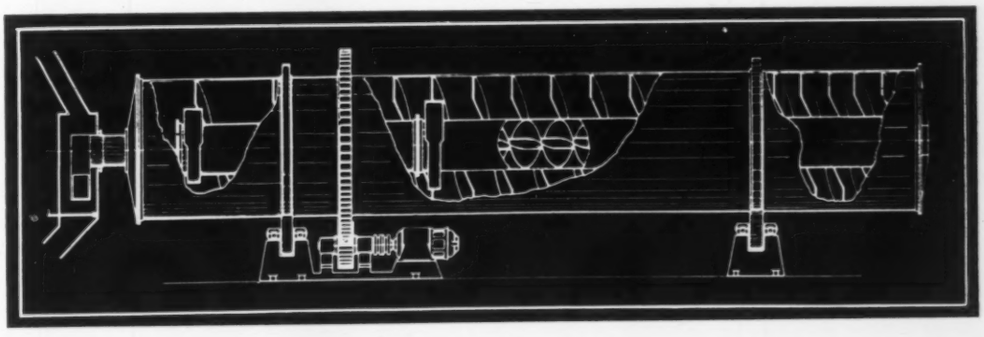


Fig. 2—Screw flights mix material by multiple divisions

Flame Hardening Applications Show Steady Increase

BECAUSE of the increasingly important role being played by surface hardening and hard surfacing in the specification of parts for machines, several of the speakers at the recent thirty-ninth annual convention of the International Acetylene association in Houston, Tex., presented information of pertinent interest to designers. Keynote of the meeting was struck by C. E. MacQuigg, dean of the college of engineering, Ohio State university, who discussed the advantages and applications of both methods.

In defining surface hardening, Prof. MacQuigg pointed out it means increasing the hardness of the superficial layers of the original metal in place; hard-surfacing means adding suitable metallic layers to the original surface. One of the methods for accomplishing both objectives is flame hardening, which may be defined as a process whereby the surface of a quench-hardening ferrous material is locally heated by means of an oxyacetylene flame followed by a suitable quench. In other words, the surface of the part to be hardened is rapidly raised to the required temperature with the intense heat of the oxyacetylene flame and then rapidly cooled, usually by water.

From a metallurgical standpoint, according to Prof. MacQuigg, flame hardening has an advantage in that no change of chemical composition takes place in the hardened surface. Flexibility is also an attribute, since only the portions of the surface which require hardening need be so affected. Other advantages are: Effective quenching, speed of operation, good case characteristics, treatment of thin sections, scale-free surfaces.

Flame hardening is adaptable to complicated parts with less danger of distortion or other faults, and is used for treatment of rail ends, pump liners, crane wheels, gears tractor shoes, sheave wheels machine ways, valves, crank and camshafts and many other parts. Prof. MacQuigg emphasized, however, that flame hardening in the case of surface hardening should not be considered a universal tool adaptable to all types of parts. Like any other process, it has limitations. For instance, it may be more economical to bath-harden a large number of small parts by means of case carburizing or nitriding.

Selecting the Material

In selecting a suitable steel to be surface hardened by oxyacetylene flame methods, two general facts may be stated: (a) Plain carbon steels can be hardened satisfactorily provided the carbon is more than .40 per cent. Upper limit of carbon is dependent upon the method of hardening used, but it is generally safe up to .70 per cent carbon or even higher, depending on the section. (b) Alloyed steels are satisfactory through a wide range of compositions, but in general because of economic factors this class of steel is restricted to the low or medium alloy types, in which the percentage of principal added elements is low. Table I shows some steels which have been successfully flame hardened.

Various hard-facing alloys of widely different compositions have been developed, roughly divided into low alloy steels, high alloy steels, nonferrous alloys and tungsten carbides and borides. The latter group, because of its extreme refractoriness, is not melted or otherwise greatly affected by the acetylene flame.

All plain carbon and low alloy steels may be hard-faced, provided the carbon content is not substantially greater than .50 per cent. Higher carbon and alloy contents require, under some circumstances, special heat treatments subsequent to the operation of surfacing, and preheating may be required. Gray cast iron and alloy cast irons may be readily hard-surfaced, but brass, copper or bronzes cannot be hard-surfaced because of their relatively low melting point.

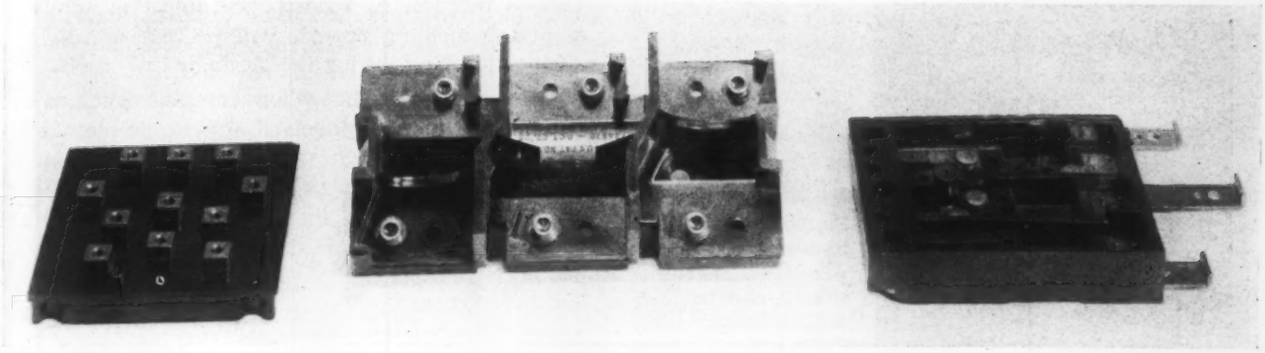
Charles H. Shapiro, chief metallurgist of the Reed Roller

(*Concluded on Page* 38)

TABLE I

Steels	Type analysis	Case Hardness*—Scleroscope	Case Hardness*—Brinell
S.A.E 1035-1070	C-.30-.80, Mn-.70 max.	50-90	350-700
S.A.E. T1335-T-1345	C-.30-.50, Mn-1.60-1.90	75-90	550-700
S.A.E. 2340-2350	C-.35-.55, Ni-3.25-3.75	70-80	500-600
S.A.E. 4140-4150	C-.35-.55, Cr-.80-1.10, Mo-.15-.25	70-85	500-650
S.A.E. 4640	C-.35-.45, Ni-1.65-2.00, Mo-.20-.30	70-80	500-600
S.A.E. 5140-5150	C-.35-.55, Cr-.80-1.10	70-85	500-650
S.A.E. 6135-6150	C-.30-.55, Cr-.80-1.10, V-.15-.20	75-85	550-650
Carbon-Vanadium	C-.45-.65, V-.15 min.	70-90	500-700
Cromansil	C-.30-.45, Cr-.40-.60, Mn-1.00-1.30, Si-.70-.90	75-85	550-650
Manganese-Molybdenum	S.A.E. T1335 or T1340 plus Mo.-.15-.25	75-85	550-650

* *Hardness determinations on flame-hardened parts should be made preferably with the scleroscope. Brinell numbers shown here have been converted. Hardness figures are for water-quenched materials.*



Why Not Combine the Plastic with the Metal?

By J. Delmonte

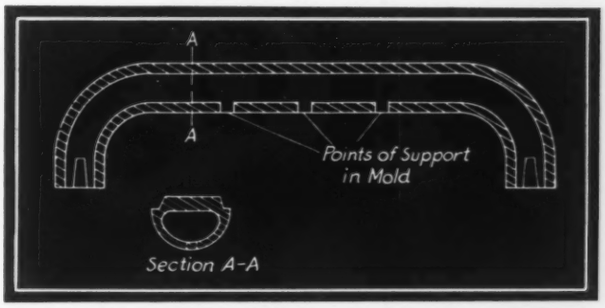


Fig. 1—Top—Molded plastic pieces with metal inserts are used as electrical conductors. Fig. 2—Above—Low thermal conductivity of plastics permits use as covers for control levers and pushbuttons

NUMEROUS designs benefit through a combination of metals and plastics, in which distinctive properties of both materials complement one another. Because of certain disadvantages possessed by plastics as well as metals, designs bringing out the best properties of each are meritorious. Such designs are not limited in their scope or methods of fabrication, as molded, laminated and cast plastic materials can be employed, as well as metal stampings, screw machine parts, die castings and metal powders.

Types of plastics or the metals used are limited in some instances. Certain plastic materials, such as the members of the polyvinyl group may deteriorate more readily in the presence of iron and zinc than other metals. The more frequently used metals and their electrodeposited coatings are seldom attacked by the plastic material compositions.

Several methods of classifying plastic and metal designs have been developed. In general, the metals are described as inserts and inlays. Metal pieces, or inserts, such as brass or steel screw machine parts, are molded directly into the plastic material, these inserts fulfilling some functional property of the part such as a point of assembly or an electrical terminal. Metal inlays, on the other hand, are present on the surface of the molded, laminated, or cast plastic part, and find greatest utility in decorative appeal. A more thorough analysis of these combinations in terms of their utility permits a more comprehensive classification, as follows:

1. Metal inserts as electrical conductors or terminals in molded and laminated plastics; or conversely, plastics as insulators in metal construction
2. Metal inserts as thermal conductors in molded or laminated plastics; or conversely, plastics as heat insulators for metallic members
3. Metal inserts as points of attachment during assembly operation
4. Plastic materials as chemically resistant coatings for metals in chemical equipment
5. Metals for mechanical strength in plastic materials
6. Plastics as decorative materials over metal members, or metal inlays on plastic surfaces.

ELECTRICAL CONDUCTORS AND TERMINALS: It is frequently necessary in the design of electrical machines

Fig. 3 — In this handle for a small portable machine the die-cast bracket is combined with the plastic grip through screw machine parts

to establish terminal blocks to which all electrical connections may be established and at the same time be readily available for servicing. No materials are as convenient as the molded and laminated plastics wherein the terminal members are either permanently molded into position or located by drilling holes in the sheet of laminated plastics. For general purpose requirements such as operation at low voltages and power frequencies the phenolic plastics are well suited, supplemented sometimes with the addition of fiber inserts for their arc-resisting characteristics. In high frequency work, where dielectric loss assumes cardinal significance, the molded insulating material for embedding the metal inserts may be polystyrene or a low loss phenolic.

Terminals Comprise Many Forms

Terminals for electrical conductors may comprise a wide number of forms, though for high production work screw machine pieces or metal stampings fulfill the requirements. A number of molded pieces and their metal inserts are shown in *Fig.* 1. Undercut hexagon or square stock or deeply diamond-knurled round stock will serve to anchor the screw machine members against twisting or pulling out from the molded member. These pieces are usually tapped beforehand, and provisions must be made in the design or the mold to avoid filling the threads with plastic material.

Metal stampings require greater ingenuity in positioning or holding in place during the molding operation. A transfer or injection mold is often employed in molding about these pieces, because the stresses tending to misalign such inserts are not as severe as in conventional compression molding. However, such a practice is not necessarily the rule, for often a judicious location of rogersboard strips in connection with the molding powder will prevent misalignment of the stamping during the closing of the mold.

It is conceivable that when stampings such as brass or copper pieces are involved, the design may be such as to extend through the molded piece, serving as electrical conductors as well as terminals. Extra pieces are eliminated in this manner and assemblies simplified. Some molded insulation blocks have as many as 100 identical metal stampings evenly spaced by the molded insulation and serving as terminals posts, carrying the electrical current through the block to terminal lugs on the opposite side. Metals as electrical conductors in molded plastics is not an entirely new idea, for wires have been employed in molded phenolic parts in telephone headsets for some time. Possible shorting of the wires is avoided through rogersboard inserts placed between wires

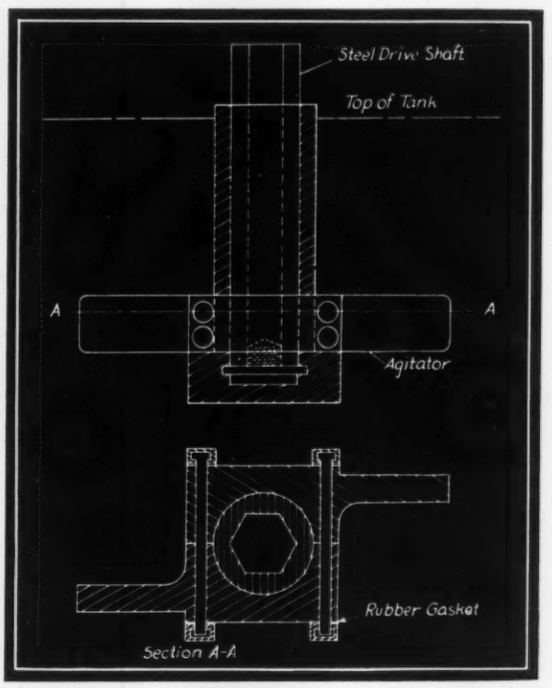


Fig. 4—As on this agitator, plastics are often used over metallic surfaces when resistance to chemical attack is needed. Metal core gives strength

prior to molding. In addition, there are extruded sections of cellulose acetate which have been applied as sheaths for electrical bus-bars, and the recently developed plasticized polyvinyl chloride with rubber-like qualities, applied as a coating for electrical wiring.

HEAT INSULATORS: Another use for metals in plastics, not so extensively practiced as for electrical conductors, is for the purpose of improving the thermal conductivity of the molded or laminated section. As an example, laminated phenolic plastics may have a strip or sheet of metal foil introduced close to the surface, between layers of paper or textile base lamina-

tions. The purpose of this metal is to conduct heat away from hot spots on the surface. Naturally, an adequate bond between the metal foil and the other laminations must be effected. This is usually attained by roughening the surface of the metal, and by perforating the sheet of metal to provide for the continuous bonding action of the resin.

Conversely, plastic materials are used as heat insulators in machine parts where temperatures are not excessive. Under these circumstances thermosetting plastics are invariably chosen, as they will not soften under heat. Plastic covers for operating control levers and pushbuttons are popular and will not transmit heat as readily as metals, thus providing no discomfort to the hand. This low thermal conductivity of plastic materials gives rise to the "pleasing touch" description of phenolics, ureas, and cellulose acetate. One manufacturer is molding a sheath of phenolic plastic about a heavy metal piece which serves as a handle. A cross-section of the piece is shown in *Fig.* 2. Provisions in the casting for an adequate support of the part during molding should be noted.

Another example of the use of plastics as a heat insulator is in a certain injection molding machine wherein the heat of the plasticizing chamber is prevented from going to other parts of the machine by means of a laminated, asbestos base, phenolic plastic material.

Inserts Aid Parts Attachment

ASSEMBLY AIDS: The use of metallic inserts in molded plastics has been of untold value in facilitating attachment of parts to the machine assembly. Screw machine pieces already tapped may be correctly positioned in the mold and appear firmly embedded in the final part. Designed with adequate wall thickness of plastic material about the inserts (at least 1/16-inch minimum), they will withstand the strains and stresses incident to handling and assembly. Plastic materials may be drilled and tapped with threads. However, such procedures constitute extra operations and the mechanical strength of the final threads is not as high as that of the metals. In *Fig.* 3, a handle for a small portable machine, the die-cast bracket for assembly purposes is attached to the handle through screw machine inserts.

Examples are numerous in molded plastics of the use of metal inserts to facilitate assembly, and examination of the stock molds of many custom molders will reveal the prevalence of such designs.

CHEMICAL RESISTANCE: The application of plastics directly over the metallic surfaces to attain resistance to chemical attack constitutes an art which has broad possibilities. Among noteworthy examples are the deposition of synthetic rubber-like materials over metals used in the vicinity of electroplating tanks, and the various uses of "Haveg," a chemically resistant phenolic composition. One application to an agitator is illustrated in *Fig.* 4, with the phenolic composition applied to a thickness of one to two inches about metal parts. While the agitator itself is entirely of phenolic material, the drive from the motor is steel and must pass through the tank. Plastic material is applied to this member as well as the heads of nuts and screws. In this manner, the plastic and metal parts combine resistance to chemicals with the strength of the metal core.

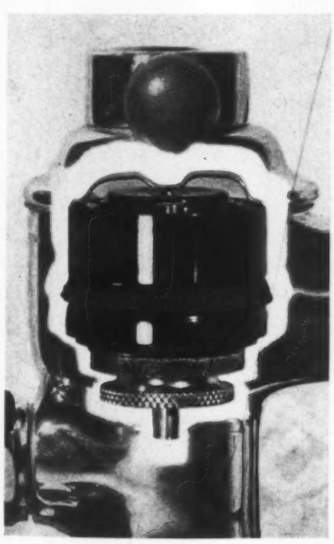


Fig. 5 — Piston is molded of a special moisture - resistant phenolic, giving quiet operation and chemical resistance

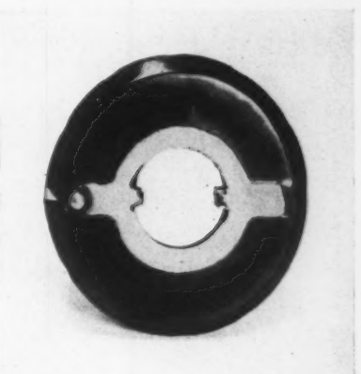


Fig. 6—Metal cores contribute to plastic strength, the two keys of the metal insert here being used to withstand heavy twisting operations

A further illustration of plastics for water and chemical resistance is the flush valve piston, *Fig.* 5, which is molded of a special moisture-resistant phenolic. Quiet operation combined with chemical resistance is its outstanding characteristic.

MECHANICAL STRENGTH: In meeting unusually severe mechanical requirements, metal cores may contribute to the efficacy of a particular design in molded plastics. Large nonmetallic gears, for example, may have a metal bushing with a key or keyway to withstand heavy loads. The plastic material itself is rarely provided with the key or keyway. The molded knob with large metal insert, shown in *Fig.* 6, utilizes the metal because of the two keys which will

withstand heavy twisting operations. Other designs benefit mechanically by the addition of metals serving as stiffening agents as, for example, in increasing the modulus of elasticity of some member under bending stresses. In designs involving considerable length of metal integral with the plastic material, care should be exercised to allow for differences in thermal expansion between the two materials to avoid creating too high a stress in the plastic during operation at higher temperatures.

Injection molding of cellulose acetate about a steel core on an automobile steering wheel is an example of a molded plastic covering a long length of metal.

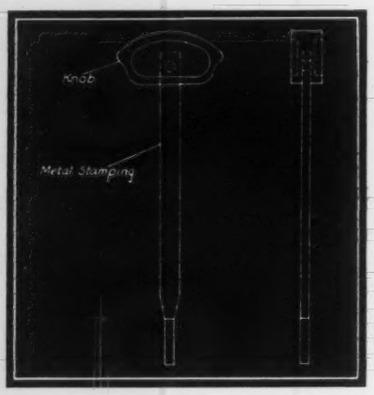


Fig. 7—Sketch of an injection - molded knob over a stamping, a circular hole in the end of the stamping providing undercut to hold the piece firmly

The plastic material in cooling from molding temperatures shrinks tightly around the core, creating a stress that is high but which the material can well withstand. In the course of time the residual stresses are relieved by cold flow.

DECORATIVE EFFECTS: Plastics have been used in many ways for decorative effects on metals, and vice versa. With the development of 32-ounce capacity machines for injection molding has come an increasing tendency to injection-mold thermoplastic materials over large die castings and sheet metal panels. While most of the work has been done in connection with automobile hardware, there is no reason why such applications could not extend to other fields, and it is likely this will occur. Among the advantages claimed for such processes is the fact that translucent plastic materials will completely hide surface defects such as pit holes, spot welds, scratches, etc., and leave a smoothly finished exterior pleasant to the touch. In fact, the applications of injection-molded opaque materials over rough die castings eliminates many finishing operations incident to such pieces. Approximately .070-inch of cellulose acetate is applied over some large sheet metal panels. If lightly translucent or semitransparent materials are to be employed, the surface of the panel should be covered with a colored enamel to enhance the decorative appeal and to add to general attractiveness.

Provisions may have to be made on the metal stampings to anchor the plastic coating in a tight bond, and slots and undercuts are generally provided. In the sketch of an injection molded knob over a stamping, *Fig.* 7, used on the choke and throttle control of a Ford car, a circular hole in the end of the stamping provides sufficient undercut to grip the piece.

Metal Inlays Achieve Unusual Effects

Metals are applied over plastics, strange to say, to achieve unusual design and decorative effects. The Chilton process, for example, has attained wide popularity. The steps in applying the metal inlays are shown in the accompanying sketch. Grooves may be cut in the surface of the plastic by a pantograph machine or else molded into position. A hard base metal is first applied, followed by an identically shaped softer metal stamping, with a slight concavity. Pressure will cause the uppermost piece to spread out and dovetail into the sides of the grooves. A tight seal is effected in this manner. Unusual design effects of metal inlays in cast, laminated, and molded parts are realized.

Another process attracting considerable interest is electroplating silver, gold, or copper on plastic surfaces. Treatment of the plastic material surface by certain chemicals will render it suitable for the applied coatings, which may be as deep as .01-inch. Attractive metallic coated pieces are obtained in this manner, possessing the characteristic light weight of the plastic. Engineering applications are being found, such as in the case of the streamlined plastic housings for aircraft radio directional, rotating loop antennas. Electrodeposited metals on these housings afford a method of grounding them to the ship structure.

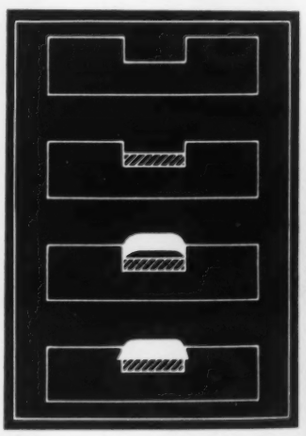


Fig. 8—Steps in applying metal inlays, unusual design effects being possible in cast, laminated and molded parts

Process and technique of combining metals with plastics are many and permit much ingenuity in the attainment of final design. While the operations may sometimes be more costly, the gain in mechanical and electrical or chemical quality offsets the special provisions that may have to be made.

Telescoping Lift Embodies Unique Drive

By J. B. Harrison
[*Economy Engineering Company*

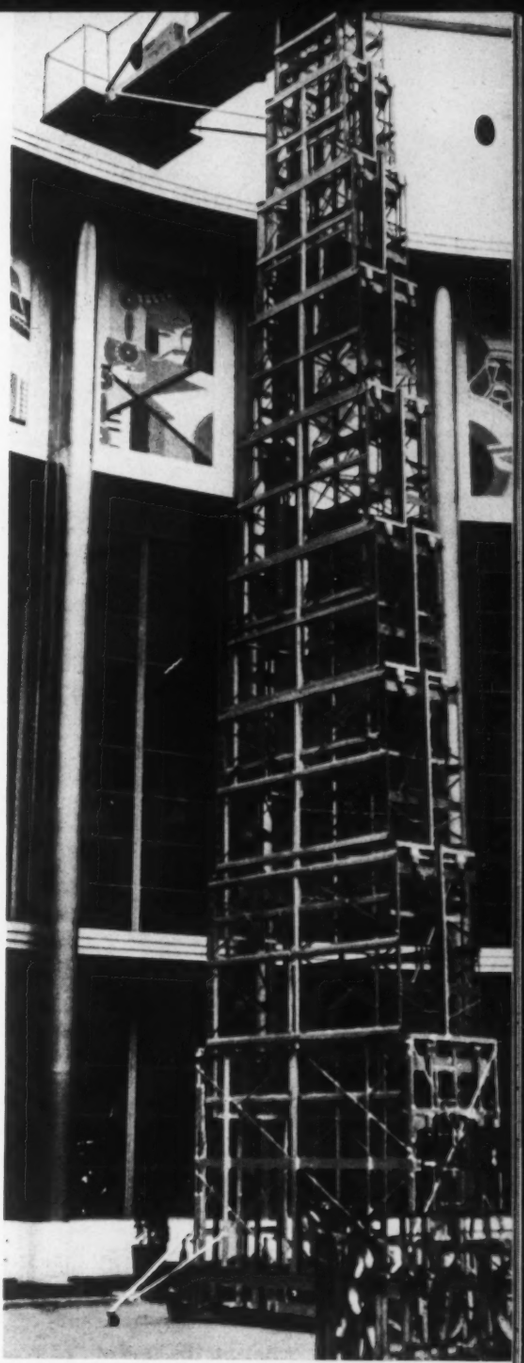


Fig. 2—Stresses caused by cantilever platform are taken care of by roller guides

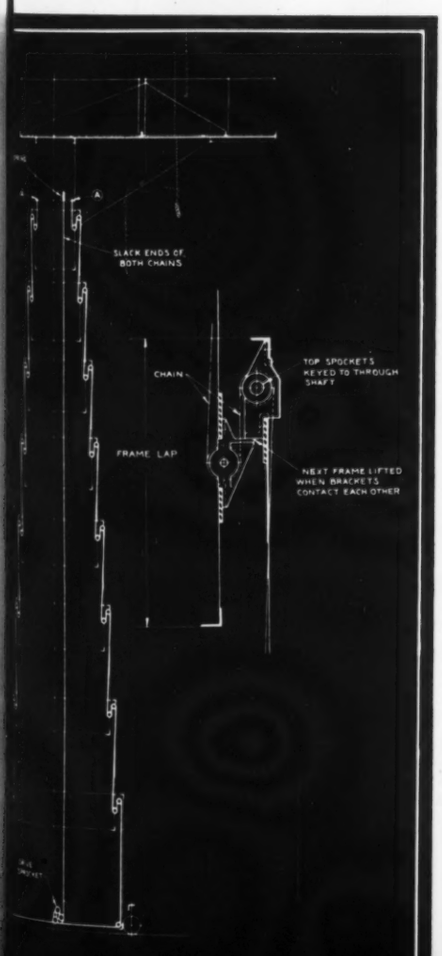

SLACK ENDS OF BOTH CHAINS
CHAIN
TOP SPOCKETS KEYED TO THROUGH SHAFT
FRAME LAP
NEXT FRAME LIFTED WHEN BRACKETS CONTACT EACH OTHER

Fig. 1—Continuous chains at each corner raise tiers and platform. Insert is schematic arrangement of sprocket mounting bracket

PRIMARY considerations in the design of a portable telescoping machine for maintenance work are rigidity, compactness and light weight. The machine illustrated was designed for the Ford Motor Co. and involves an additional problem of providing an eight-foot overreach or cantilever platform.

A series of rectangular frames or tiers of varying sizes, such that in the down position each frame is nested inside the next larger, composes the structure of this machine. Because of its height and the number of sections, all moving frames are structural aluminum to decrease the load to be lifted. The base section is steel to give added stability.

Of especial interest in this multiple telescoping machine is the arrangement of the lifting chains and the guide construction. Four roller chains, one at each corner, lift the frames one at a time, starting with the smallest. Each frame picks up the next when its bottom sprocket brackets contact the steps on the top sprocket brackets of the succeeding frame, as shown in *Fig.* 1. Having brackets at all four corners pulled consecutively into contact by the chains, the frames are held tightly and form a rigid unit.

Inserted in the drawing is a schematic diagram of one pair of chains with the machine in the extended position. This pair of chains is tied to a similar pair on the opposite side of the machine, for the other two corners, by means of shafts to which the top sprockets are keyed. Thus all four

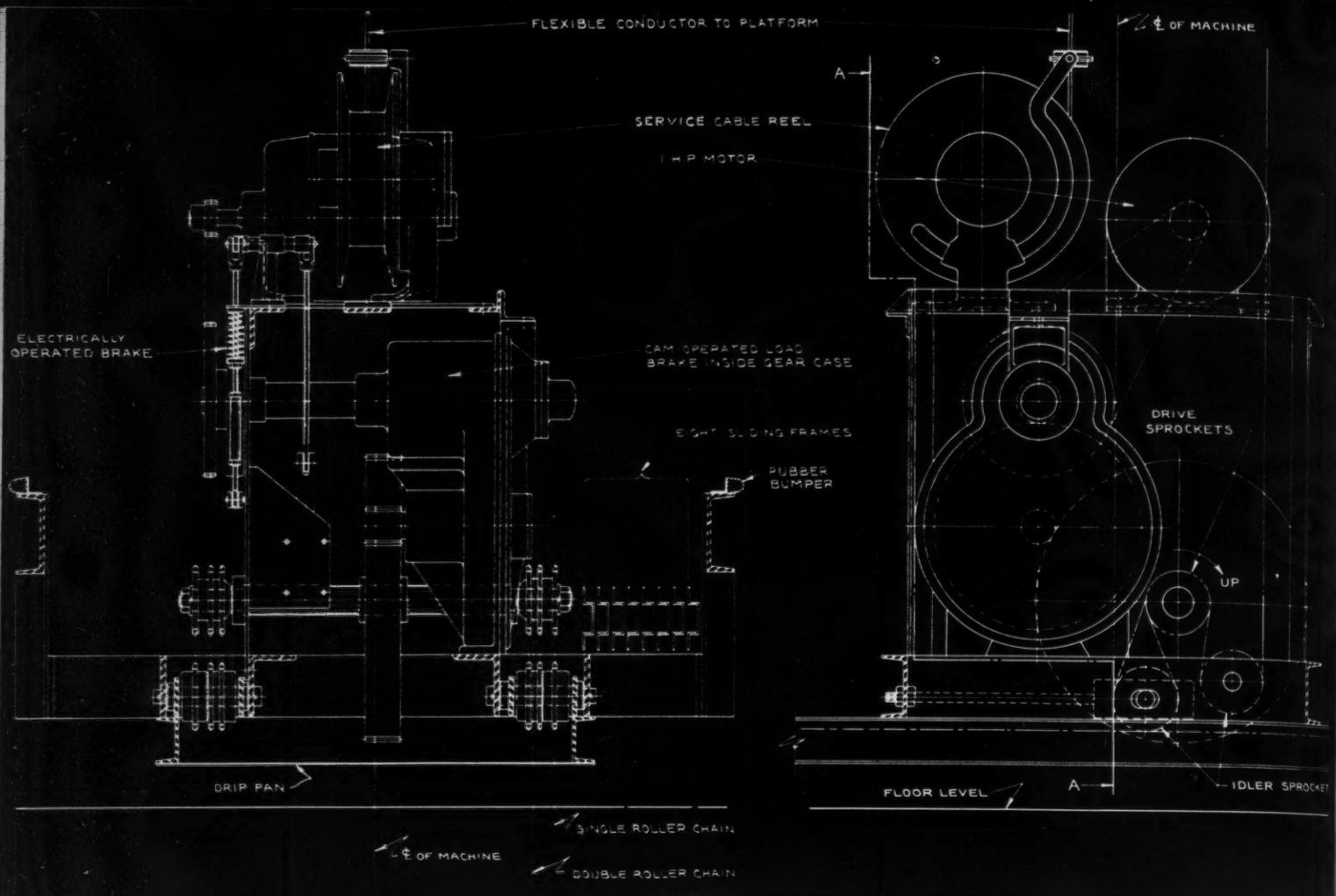


Fig. 3—Motor drives chain sprockets through gear reduction unit. Cam-operated load brake enables motor to drive in lowering the platform

corners are lifted evenly and smoothly.

As can be seen in the drawing, a typical chain fastened to the smallest frame at "A" is led down over a sprocket at the bottom of that frame, then up over the top, and down to the bottom sprockets of the next frame. In this manner it passes through all the frames and at the bottom of the main frame is brought to the main drive sprockets in the center of the machine. The slack side passes over an idler sprocket and then back up to the top frame, where it is fastened with a spring connection to maintain tension. This forms, in effect, a continuous chain since the chain drawn over the driving sprocket as the frames rise is carried up with the platform frames.

Hoisting is accomplished through a unit in the center of the machine. The hoisting assembly is shown in *Fig.* 3 and consists of a main shaft with sprockets at each end driven through spur gears by another gear reduction enclosed in a case and running in oil. This is in turn connected by silent chain drive to a one-horsepower reversing motor, giving a lifting speed of seven feet per minute with full load.

In addition to an electrically operated external contracting band brake, there is incorporated in the gearcase a load brake of the cam-operated type. This assembly is illustrated in *Fig.* 4 which shows a section through the gearcase, and consists of two complete sets of friction plates and cams, one to hold the load and one to permit lowering.

The top shaft, supported at each end on ball bearings, passes through a support tube and has the driving sprocket keyed to it at one end, and one half of the lowering pair of cams at the other. The mating half of the lowering cams is free on the shaft and is integral with the pinion gear and a large thrust plate. Thrust of the cams is transmitted through a friction disk to another thrust plate which, by means of a pair of arms, transmits motion to the holding cams.

Brakes Hold if Power Fails

The holding cam is mounted on the support tube and the pressure of the cams is transmitted through another friction disk to a holding plate which is held from turning by a tongue fitting into a groove in the gearcase.

When the shaft is rotated in the "up" direction as indicated by the arrow, the lowering cams tight-

en turning the pinion and thrust plates as a unit. This motion is also transmitted to the holding cams, which are of opposite hand and free to rotate. With the shaft at rest, backward pressure on the pinion caused by the load, tightens both sets of cams and applies pressure on the holding plate, effectively holding the load. In lowering, the reverse rotation of the shaft frees the lowering cams, permitting the pinion to revolve although the holding cams remain in the locked position. During lowering, the friction on the thrust plate and disk is proportional to the load, the assembly acting as a brake to control the speed of lowering. In effect, the motor drives the load down at motor speed.

It is apparent that the principal function of the electric brake mentioned earlier is to check the momentum of the motor quickly and stop the shaft,

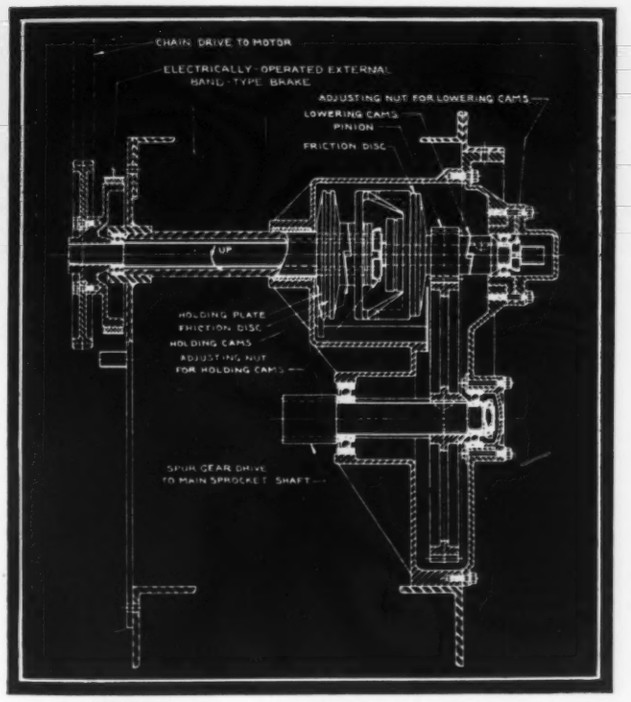


Fig. 4—Section through hoisting unit gearcase showing cam-operated load brake and electric brake

while the cam assembly holds the load. Both brakes will function in event of current failure although either is capable of holding the load independent of the other.

Guides Prevent Sway

To hold the frames in alignment and prevent side sway, vertical sliding type guides, shown in plan view in *Fig.* 5, are provided in the center of both ends of the frames. They consist of extruded alumium sections riveted to the outside of the frames, with bronze guide shoes at the bottom ends and steel guide strips along both sides. These outside guides mate with another set of guides on the inside of the next larger frame, consisting of pairs of aluminum angles with bronze guide shoes at the top ends and steel guide strips along the inside. With bronze shoes at the bottom of one frame and at the top of the mating frame, the effective guide lap which limits sway is the full length of the frames when nested, gradually diminishing as the one frame slides out of the other until it reaches its minimum when the next frame is picked up by the lifting brackets. After the frame is picked up the two frames are held in contact at four points and form a rigid unit with virtually no side load on the guides.

Cantilever Thrust on Rollers

This cantilever load resulted in considerable end thrust in the frames, making it necessary to use guide rollers at one end of the machine. Typical top and bottom guide roller assemblies are shown in *Fig.* 6. These guide rollers are mounted on both sides of the frames at the end nearest the overhung load. In a typical pair of mating frames the top rollers are mounted at the top of the larger frame and bear against flat steel guide strips on the smaller frame, while the bottom rollers are mounted at the bottom of the smaller frame and bear against steel guide angles riveted to the inside of the larger frame. Top rollers are mounted on eccentric shafts to permit adjustment. The effect of having the rollers at the top of the larger frame and at the bottom of the mating frame is the same as in the center guides, in that the effective guide lap is the full length of the frames when nested, gradually diminishing as the smaller frame rises.

Inasmuch as this end thrust is more severe in the smaller frames, the minimum frame laps are made progressively larger toward the top of the machine. As each successive frame is picked up its weight is added to the counterbalancing load so that with approximately half the frames raised the cantilever load is more than counterbalanced and the guide

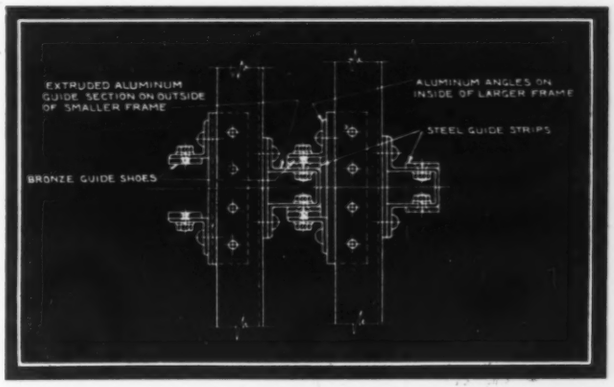

EXTRUDED ALUMINUM GUIDE SECTION ON OUTSIDE OF SMALLER FRAME
ALUMINUM ANGLES ON INSIDE OF LARGER FRAME
STEEL GUIDE STRIPS
BRONZE GUIDE SHOES

Fig. 5—Vertical sliding guide rails hold frames in alignment and prevent sway of structure

roller load on succeeding frames is negligible. The overhanging load also increases the load on the lifting chains at that end of the machine. For this reason these chains are of the double roller type.

The motion of the platform is controlled by pushbutton stations on both the platform and base sec-

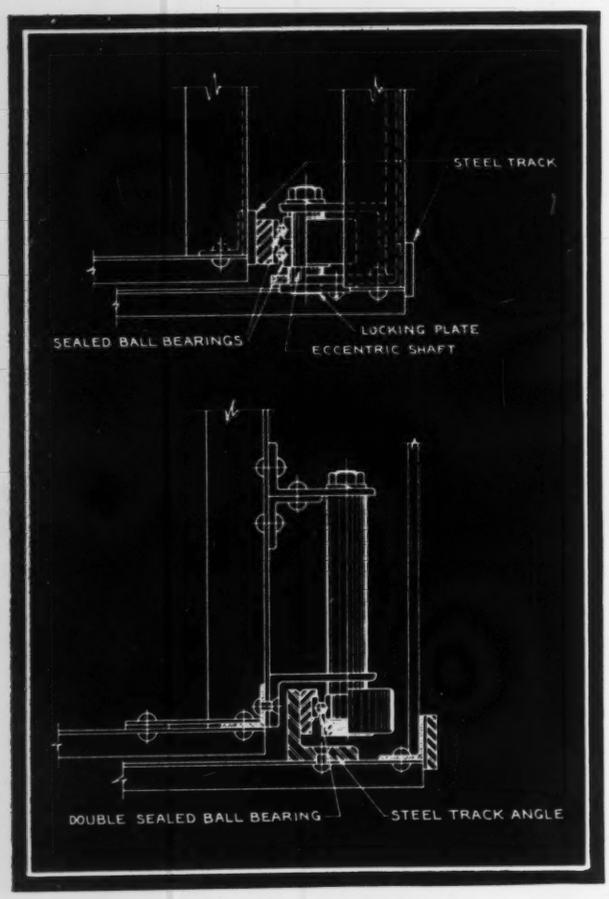


Fig. 6—Guide rollers take thrust of cantilever platform and reduce the friction load

tion. Current is carried to the platform by means of a cable reel which pays out the cable as the platform rises. The platform pushbutton station is provided with a "lock-out" stop button to prevent operation of the machine from below while men are working.

All basewheels are adjustable vertically to permit leveling on unequal or sloping floors and are, in addition, so constructed that they can be turned 90 degrees to facilitate moving the machine sideways.

To serve as a clearing house for information on corrosion and its prevention, a number of technical societies and other organizations have formed the American Coordinating Committee on Corrosion. This Committee will compile data available, follow researches in progress in the field and list individuals and organizations interested in the subject.

Flame Hardening Shows Steady Increase

(*Concluded from Page* 30)

Bit Co., Houston, Tex., discussed the oxyacetylene application of hard-facing materials, particularly the tungsten carbides, to oil well drilling bits. Cast carbides, as distinguished from sintered carbides, are used on bits.

In building up a blade it is necessary to weld out from the cutaway edge with a material having physical characteristics approximately the original base metal. In order to control the molten metal from the "building-up" rod, a copper back-up templet or form is used, generally ¼ or ⅜-inch roller copper plate, curved slightly or formed according to the shape of the bit and the plan of the welder. Carbon blocks may also be used for this purpose.

The question of heat treatment after building-up and hard-surfacing operations is important. Mr. Shapiro recommended a treating procedure of some kind, a simple one being normalizing from 1550 degrees Fahr.

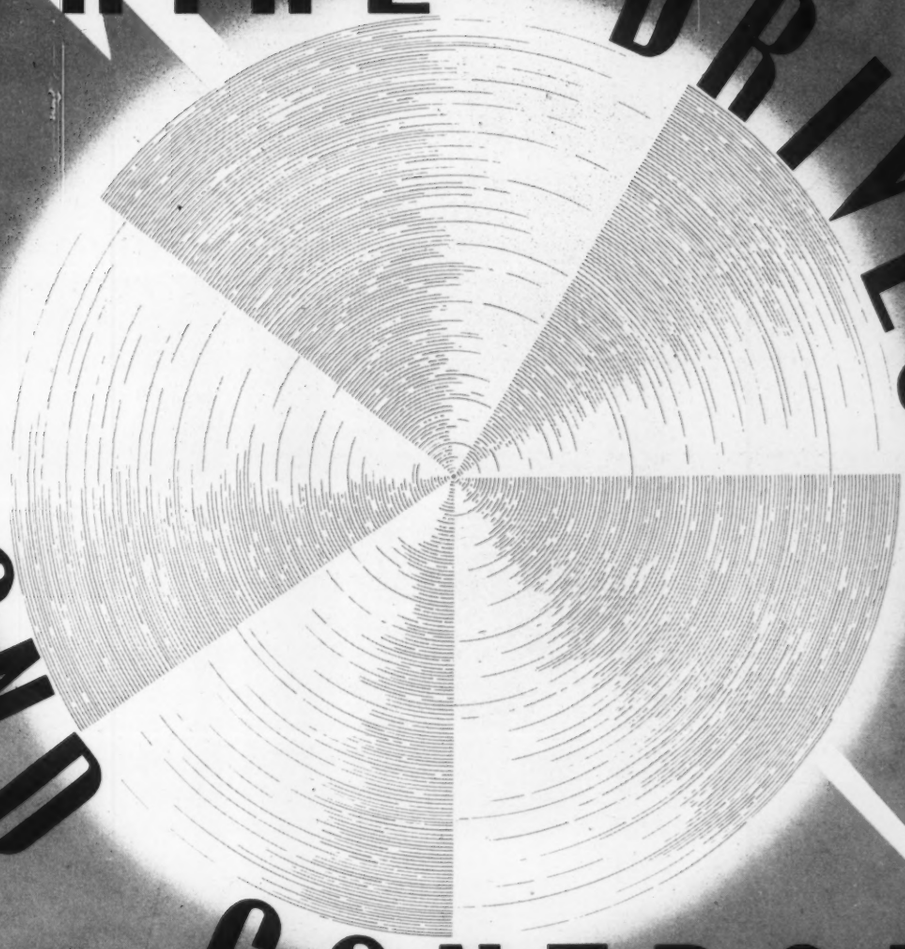
Travograph Heats Teeth

Use of flame hardening in the manufacture of various parts of oil well drilling equipment such as shafts, bearing races, clutch jaws, keys and sprocket teeth, was discussed by Michael O'Hara, International Derrick & Equipment Co., Beaumont, Tex. The company uses sprockets cast from S.A.E. 3135 chromium nickel steel which reacts well to flame hardening and water quenching.

A flame cutting travograph, equipped with a flame hardening torch with two adjustable tips, is used to heat teeth, tips being designed to heat the two wearing sides of a tooth simultaneously. This machine has a magnetic roller with a variable speed motor to control its movement along any steel surface, speed of travel of the tips obviously being also controlled by this motor. Sprockets of a like number of teeth and pitch diameter are completely machined and then mounted and keyed on a mandrel fitted with an inclining head so designed as to permit the sprockets to rotate with the mandrel, one tooth at a time. The loaded mandrel is set into the machine with the first sprocket in line with the flame hardening tips. At the end of the pass the magnet is released, the torch swung clear of the sprockets and returned to starting position.

This brief review indicates the rapid acceptance of flame hardening and hard surfacing, but it is reasonable to predict that only a start has been made. Just as corrosion-resisting steels opened entirely new possibilities in modern technology, so will these new means of combating wear prove equally useful in the solution of many problems.

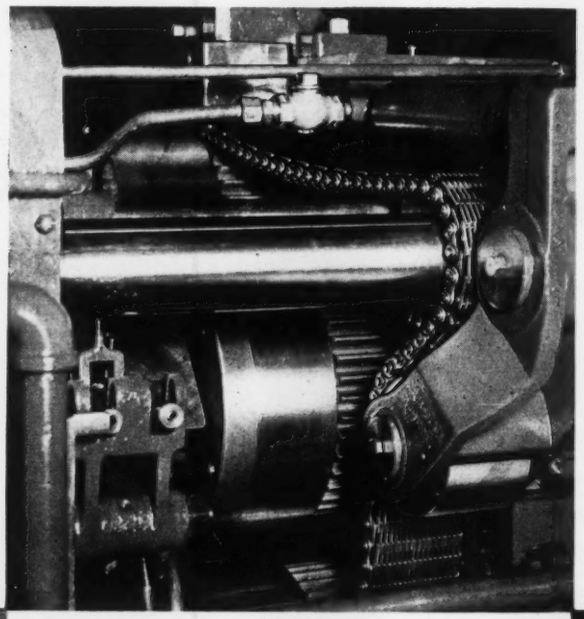
MACHINE DRIVES AND CONTROLS

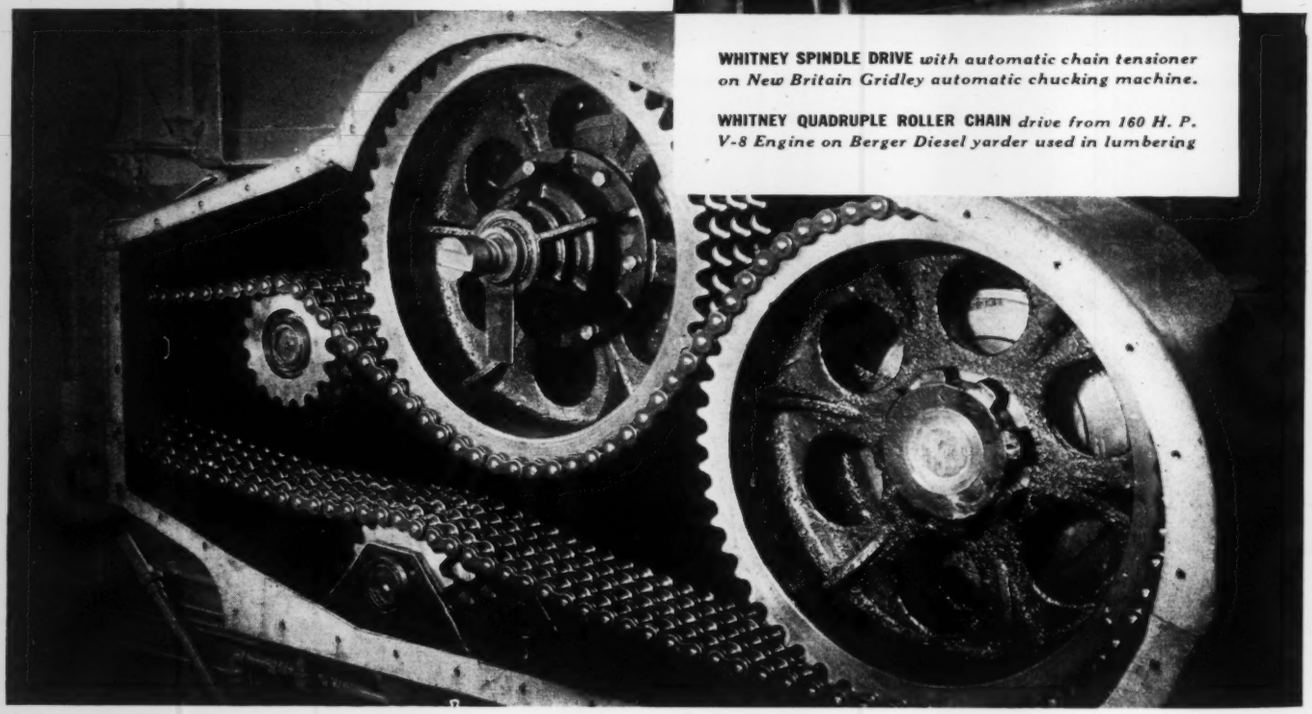


Drives and controls, common to every type of machine, are covered authoritatively from the standpoint of selection and application in this removable supplement to MACHINE DESIGN'S April, 1939 issue

Put on a Drive for Positive Power

...PUT WHITNEY CHAINS ON YOUR MACHINES





WHITNEY SPINDLE DRIVE *with automatic chain tensioner on New Britain Gridley automatic chucking machine.*

WHITNEY QUADRUPLE ROLLER CHAIN *drive from 160 H. P. V-8 Engine on Berger Diesel yarder used in lumbering*

There's never a slip between the source of power and the point of its application . . . when Whitney Chain Drives are in charge of transmission. That's a matter of record in the performance of many well-known modern machines. Full production capacity is positively maintained, by constant speed that helps to safeguard product uniformity.

You can get Whitney Chains for any type of service . . . with flexibility to fit into your design requirements . . . plus the important facility of quick installation and removal without moving shafts and bearings. Investigate the proven advantages of applying Whitney Chain Drives to *your* machines. Whitney engineers are at your service. Call them in.

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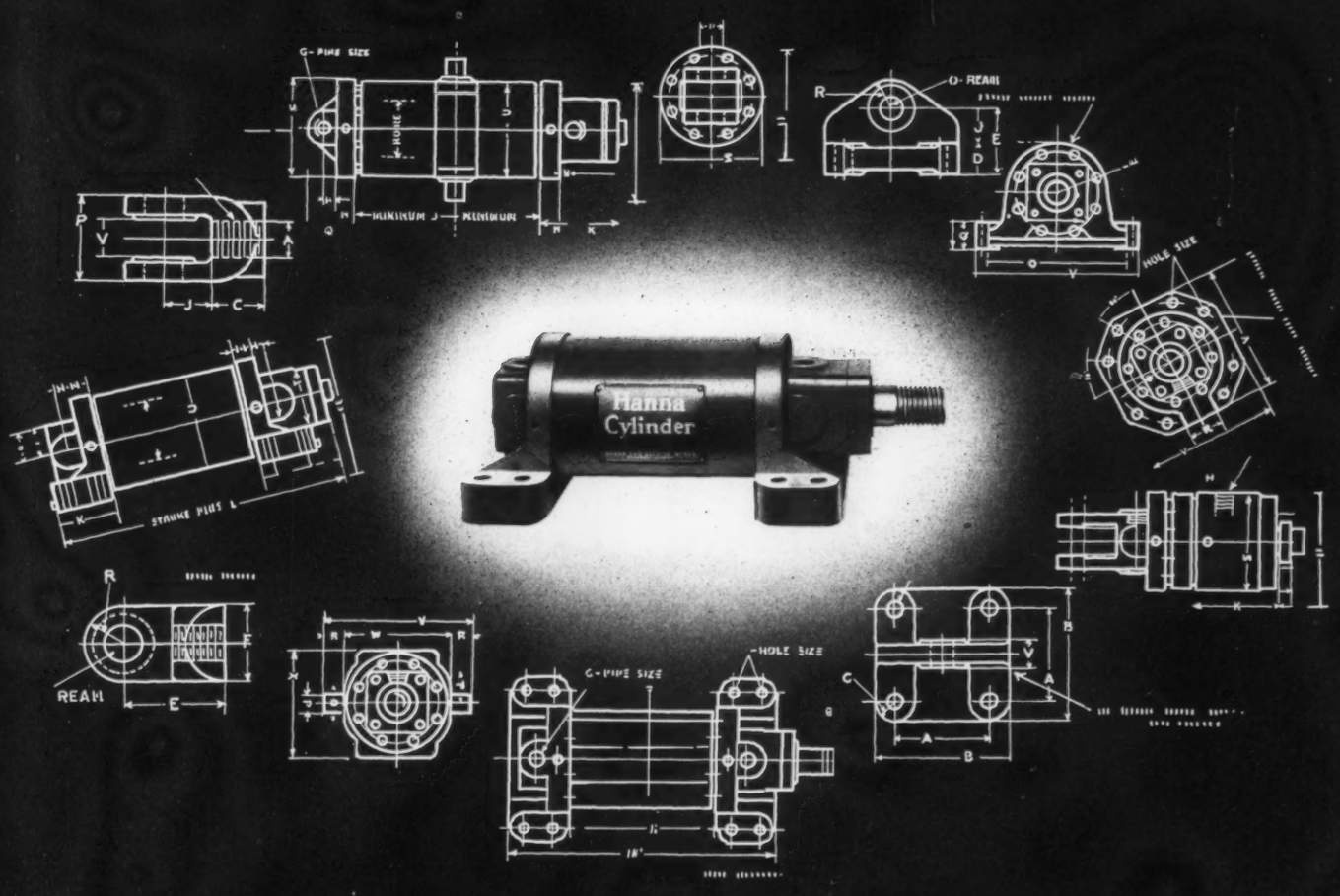

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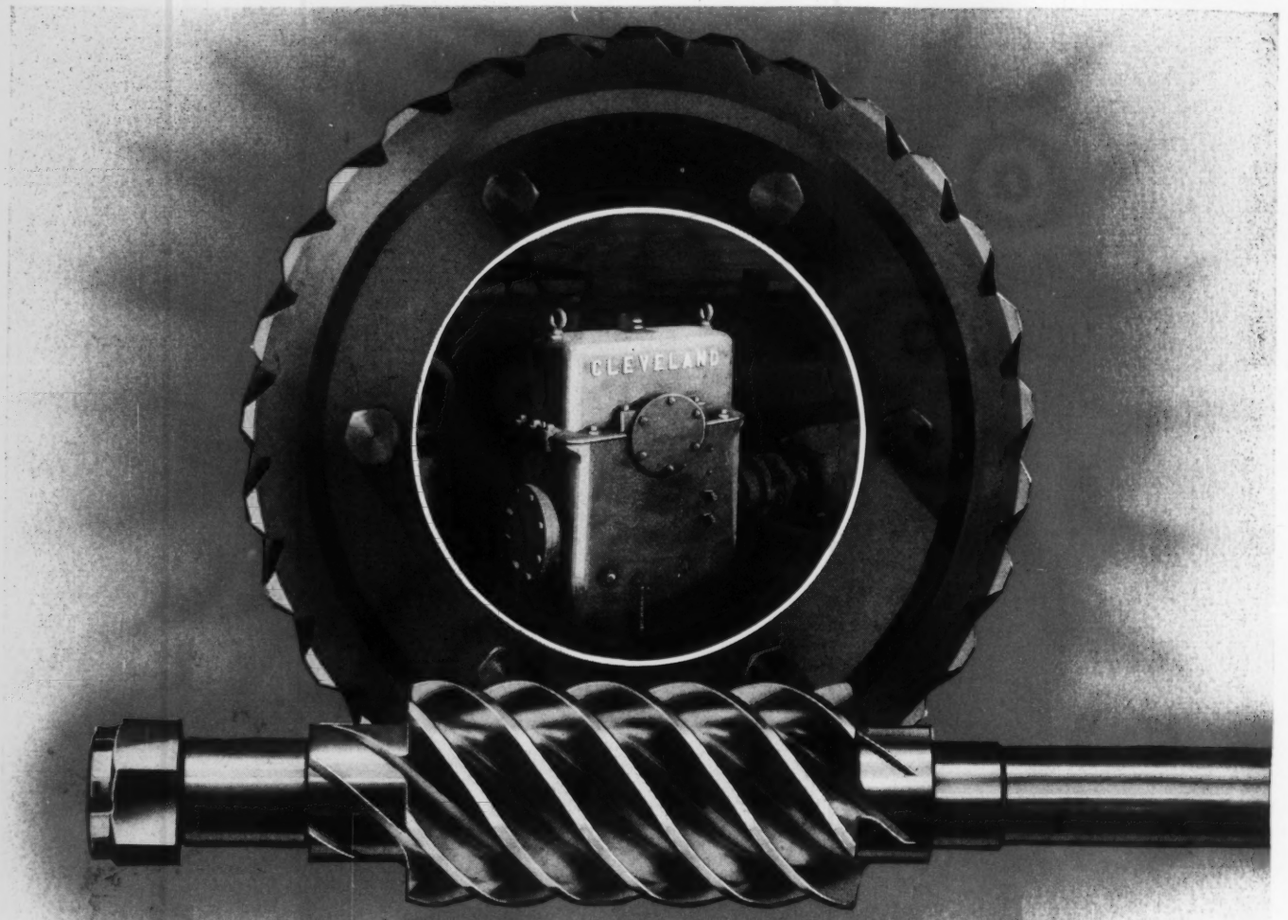


CLEVELAND DRIVES MAKE MACHINES PAY BACK FASTER

CLEVELAND'S consistent appearance in this Supplement each year, reminds you of the Company's long and successful experience as designer and builder of Worms and Gears exclusively, since 1912.

This page and this issue supply an appropriate background for the principal reasons underlying Cleveland's sound growth: (1)—their application by Design Engineers into an increasing number of industries and for an expanding variety of machines; (2)—the volume of repeat orders with which we have been favored continually.

Thousands of Design Engineers know *by their own experience* that Cleveland Worm Gear Drives *do* make machines pay back faster. *You* can secure the same dependability and increased earning power from the equipment you build, without paying a premium—because, on the basis of delivered horsepower and comparable design, you pay no more for the outstanding service that Clevelands provide.

Does your Reference Library contain a copy of the Book "Cleveland Worm Gear Speed Reducers"? It includes nearly 150 pages of indispensable Engineering Data and installation views. You should have a copy by all means—we will gladly send one upon request.

The Cleveland Worm & Gear Company, 3275 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

CLEVELAND WORM · GEAR *Speed Reducers*

THE TRUE STORY OF A BOSTON BAKER*

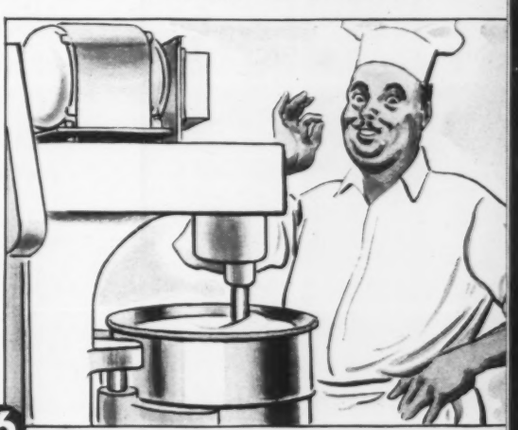
1 **Bang! . . . .** There went another fuse. That new pastry mixer was stalled again. "So," said I to myself, "if the Mixquick Company thinks I'll pay for this machine, they're crazy!"

2 **I was so mad** I called them up long distance. "The motor on my new mixer," I bellowed. "It won't go. Stalls and blows fuses all the time. Fix it, or I'll ship it back!"

3 **"So they've got no service man** anywhe near Boston!" I stormed, even after I hu up. "O. K. This time, I'll mix by hand. B never again a Mixquick Machine."

4 **Imagine my surprise** that afternoon when in walks an engineer to look at the mixer. "I'm from the G-E office in Boston," he says. "Mixquick wired us you're having trouble with the G-E motor on your new mixer."

5 **In a few minutes** he found out I needed a larger motor for such heavy dough. I remembered then that I'd ordered the mixer for light cake batter. Now I needed it for heavy pastry dough.



6 **Next day** I paid them to bring over a bigger motor from the G-E warehouse. And the Mixquick mixer—she's a dandy. Now that the motor's big enough, I believe she'd stir concrete!

THIS story is a typical example of how G-E service helps build good will for machinery manufacturers who use G-E equipment. If you, too, sell machines in all parts of the United States, you'll find it a real trouble-saver to equip them with G-E motors and control. No matter where your customers are located, they can always get quick electrical service from one of our 80 sales offices, 28 warehouses, or 25 service shops.

You don't have to worry about the electrical end of your machines once they are in the field. We'll be glad to take care of that. We'll also be glad to help you with the electrical problems in designing machines. Just call the nearest G-E sales office. General Electric, Schenectady, N. Y.

**A true story, in General Electric's service files, although of course the name MIXQUICK is fictitious.*

GENERAL ELECTRIC

011-442

CASE STUDIES OF CO-OPERATION IN BUILDING BETTER MACHINES—NO. 6

HOW Co-operative Engineering Solved a Complex Design Problem —with the Aid of G-E MOTORS

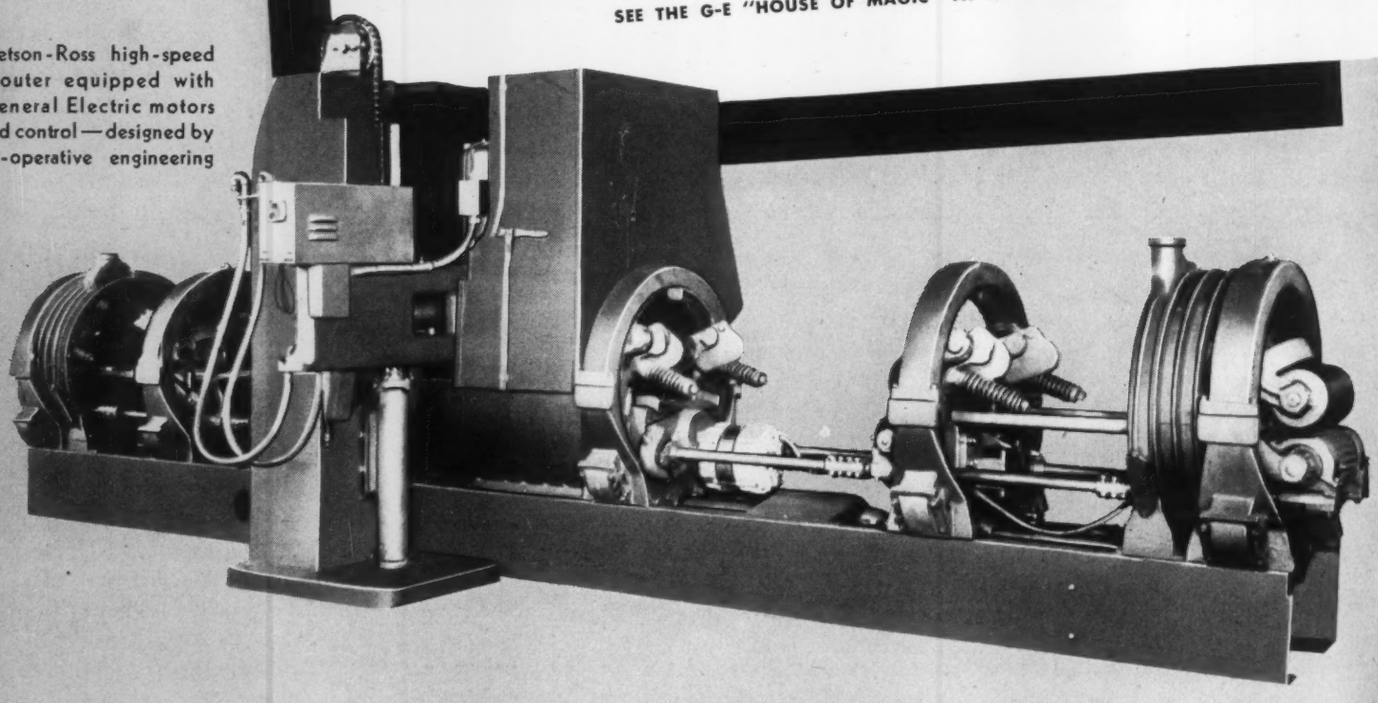
IN the designing of the Stetson-Ross high-speed Brouter* for boring out knots and routing out ingrown bark seams, rotten spots and other defects in logs, the selection of the motor drives presented one of the most important problems. It was important because the drives had to be able to turn, as well as traverse, to any position many times a minute so that the Brouter could easily reach any defect in the wood.

G-E application engineers went to work, in co-operation with Stetson-Ross designers, to determine the drives that would be able to withstand the rapid reversing as well as provide the high speed necessary for the Brouter bits. The solution was the selection of a 45-hp, 10,800-rpm, high-frequency motor for the Brouter drive and five individual built-in motors for the turning and traversing mechanism.

G-E facilities are available to you, too, for assistance in tailoring electric equipment to your machines. You can get the advantages of a modern, simplified design and greater manufacturing economy, and thereby promote customer acceptance of your machines, by taking your electrical problems to General Electric, Schenectady, N. Y.

*Trade-mark

SEE THE G-E "HOUSE OF MAGIC" AT BOTH FAIRS



Stetson-Ross high-speed Brouter equipped with General Electric motors and control—designed by co-operative engineering

GENERAL ELECTRIC

020-362

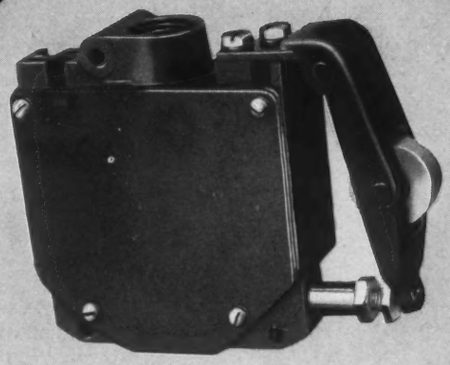
3 NEW SWITCHES

TO LINK MOVING PARTS WITH ELECTRIC CIRCUITS

A LIMIT SWITCH for controlling electric circuits through a mechanical motion is a very important factor in the success—and the safety—of an automatic machine. That's why we have built into these three limit switches the qualities demanded for machine-tool use.

They have oilproof enclosures to suit them for work where they're needed. Sturdy, long-lived mechanisms are your assurance that they can be depended upon. Interchangeability of operating mechanisms means standard mounting dimensions on different machines, and simplifies maintaining of stocks.

These switches are suited to operation under conditions that would be too severe for lighter-duty limit switches. A General Electric representative will be glad to call and give you information on the dozens of G-E limit switches which, like these, are designed to do a particular kind of work. General Electric, Schenectady, N. Y.



INTRODUCING the extra-long-lived CR9440-F1 limit switch. Sturdy, oilproof enclosure and specially constructed Alnico snap-action mechanism make this switch notable for its long life. Left- or right-hand roller lever or push-rod operation.

NEW oilproof reversing limit switch, CR9440-B1. Heavy enclosure, sturdy Alnico snap-action mechanism, and long-lived contacts make this a switch to be depended upon. Operating lever as shown.

INTRODUCING the oilproof all-purpose CR9440-D2 limit switch. A compact, dependable, snap-action switch that's easily mounted in any position, with support on back or side. Left- or right-hand roller lever or push-rod operation.

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Please send me copies of the three publications on limit switches shown at the left.

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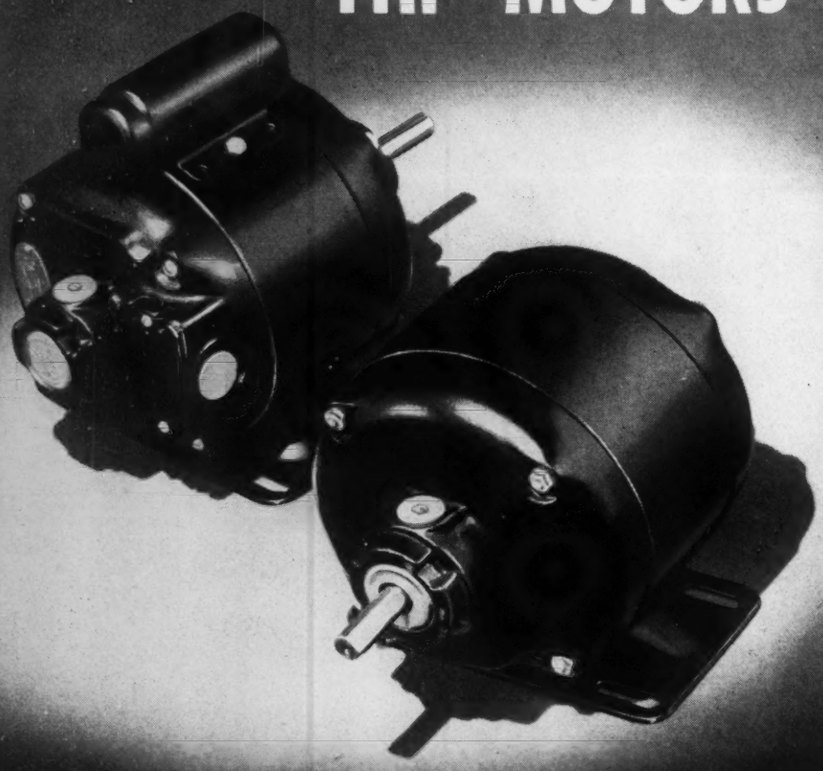
GENERAL ELECTRIC

LOW-MAINTENANCE FHP MOTORS



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- DAIRY EQUIPMENT
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WHETHER for start-and-stop service on lifts and hoists or for continuous duty on pumps and compressors, General Electric fractional-horsepower motors will operate your machines long and dependably with little or no attention. Their construction embodies years of experience in building motors to meet the load demands and conditions encountered in applications like those listed above. Large overload capacity is provided for peak loads. Bearings are large and require only occasional oiling. The latest type of insulation — resistant to moisture, oil, and mild acids and alkalis — is used.

Standard G-E motors with the proper electrical characteristics and mechanical features are available for *your machines* — motors with high or low starting torque; motors that are dripproof, explosion-proof, or totally enclosed; motors for solid, resilient, flange, or vertical mounting; to mention but a few. Speed ratings range from 3450-rpm, two-pole motors to 5.7-rpm gear-motors. For additional information on G-E motors, contact the nearest G-E sales office or write to General Electric, Schenectady, N. Y.

SEE THE G-E "HOUSE OF MAGIC" AT BOTH FAIRS

ANY TYPE YOU NEED

Split-phase Motors
1/40 to 3/4 hp
Moderate starting torque
Single-phase

Capacitor-motors
1/8 hp and larger
High starting torque
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Gear-motors
Single-phase, polyphase, or direct-current

Polyphase Motors
1/6 hp and larger
Same mounting dimensions and characteristics as other G-E Motors

Direct-current Motors
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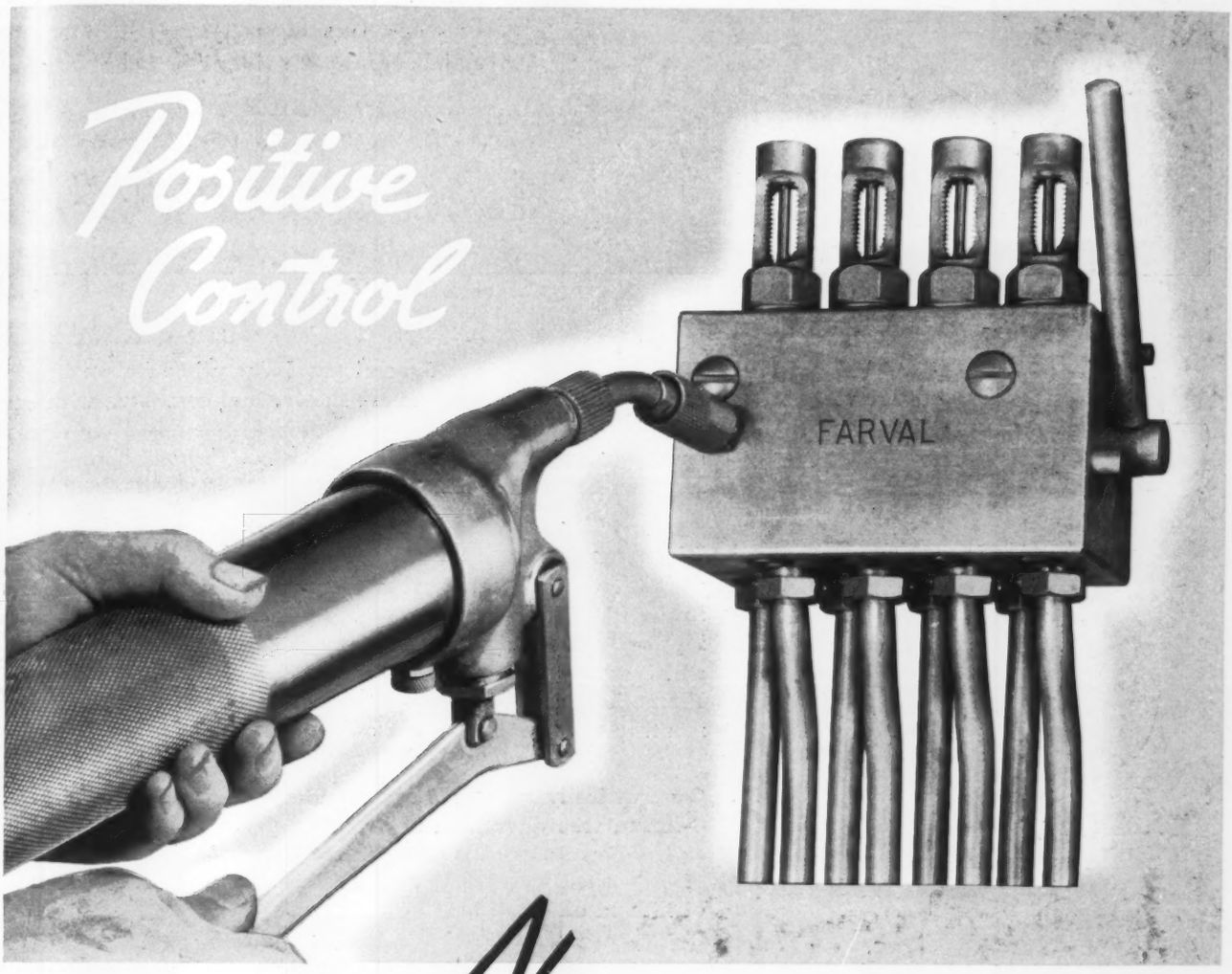
Interchangeable with a-c motors

GENERAL ELECTRIC

070-280



• • • • A *New* CENTRALIZED LUBRICANT MEASURING VALVE

• Put positive control between your present pressure gun and your bearings.

Why continue to guess as to how much lubricant (if any!) is delivered to your bearings? Why make an individual connection to each bearing, with no assurance that the job is done properly, when—

You can grease several bearings from one connection, giving every bearing an exact, measured amount, and have a tell-tale indicator to show the job is done? The amount delivered to each bearing is adjustable and—not a bearing is missed.

You can obtain this positive control with the new Farval Multiple Measuring Valves. They are extremely simple in design; can be readily installed by your own men at nominal cost; and will last as long as the machines you build.

Add to the value of your machines. Make them more salable. Reduce customers' claims for parts replacement resulting from failure to lubricate all bearings properly.

Write for bulletin describing the new Farval Multiple Measuring Valve. The Farval Corporation, 3265 East 80th Street, Cleveland, Ohio.

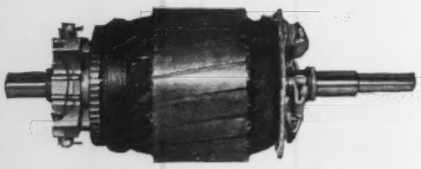
Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing

FARVAL

MULTIPLE MEASURING VALVE

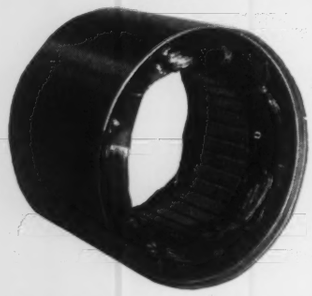
CHECK THESE FEATURES of Wagner Motors

Rotor



All Wagner rotors are dynamically balanced to insure freedom from vibration. Rotor slots are skewed and combined with careful electrical design to insure a motor with a minimum of magnetic noise. Rotor shaft is designed to carry mechanical overloads without perceptible deflection.

Stator



Wagner stators are known for their strength and rigidity, in addition to their mechanical simplicity. Stator coils are well insulated and securely wedged in place. Stator core and windings are thoroughly impregnated with heavy insulating varnish and carefully baked in drying ovens to drive out all moisture. Frame is of rolled steel—strong, rigid, will not get out of alignment.

Endplates and Bearings

Concentrically machined endplates and diamond-bored bearings —insure true alignment of bearings, perfect centering of shaft, and uniform airgap. Oil wells are roomy—hold large quantity of oil-soaked wool yarn which carries an uninterrupted supply of filtered oil to all bearing surfaces.

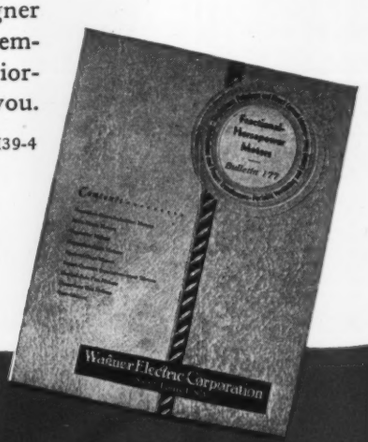
Base Construction

Wagner fractional-horsepower motors can be equipped with either rigid-mounted base, resilient-mounted base, or flanged or machined endplate mounting. Bases are formed from steel plate and are of electric-welded construction. Mounting slots are so spaced as to permit interchangeability of motors of the same frame size.

There are many other details about Wagner fractional-horsepower motors that should be of interest to engineers and manufacturers of motor-driven machinery and appliances. Wagner welcomes an opportunity to demonstrate their features of superiority that will prove useful to you.

M39-4

ASK for this Bulletin No. 177 on Wagner Fractional-Horsepower Motors



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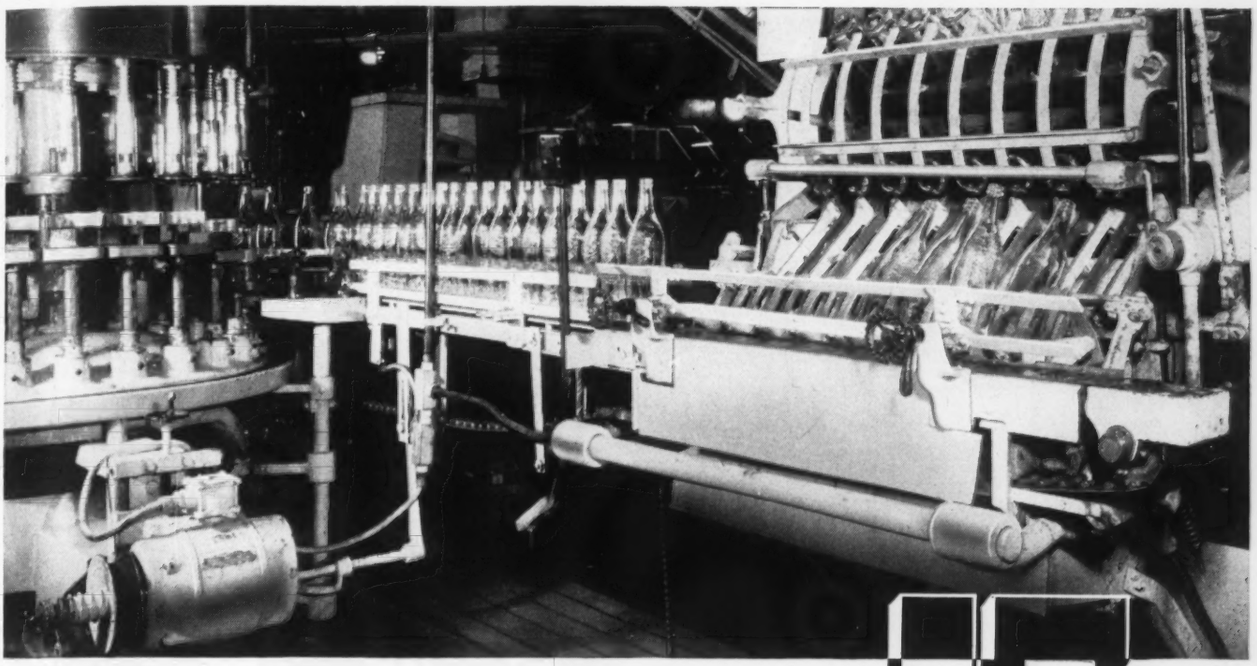
ON BOTTLING, SEALING, CAPPING AND PACKAGING MACHINES



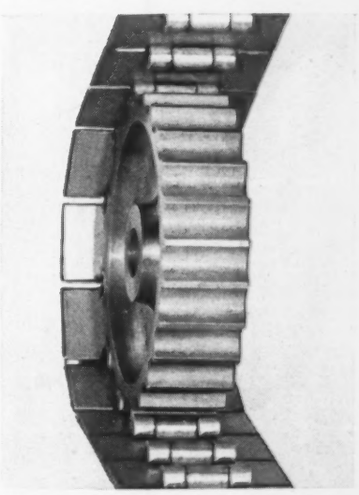
HERE'S HOW TO HANDLE WITH NEW AND GREATER ECONOMY!

Here's the biggest "chain news" in years for manufacturers and users of bottling, sealing and capping machinery! Introduced only a short while ago, Rex S-815 Flat Top Conveyor Chain has been accepted enthusiastically by several of the leading users of this type of chain!

Here's Why This Rex Chain Is News!

This completely new chain is built on the time-proved, superior principle of making the flight integral with the link. A quick review of some of its advantages shows you a far simpler, one-piece design; a wider, longer-lived sprocket bearing surface; a smaller opening between links. Too, this new chain is easily attached or detached without coupler links, easier to clean. *And it fits the same tracks as all conventional steel flat top chains!*

A special book has been prepared to give you the whole story. Use this coupon to get your copy—see why "cost-conscious" men in the food industries hail this Rex Chain as the biggest news in years!



The new Rex Flat Top Conveyor Chain, with its unique sprocket. Well beveled edges allow containers to slide freely when jams occur.

REX DRIVE AND CONVEYOR CHAINS

CHAIN BELT COMPANY of Milwaukee

CHAIN BELT COMPANY
1643 W. Bruce Street, Milwaukee, Wis.
Please send me my copy of Bulletin No. 335, "Rex Flat Top Conveyor Chain."

*Firm Name*_____

*By*_____ *Title*_____

*Address*_____

*City*_____ *State*_____

SPOILAGE

Inability to obtain correct machine speeds to match skill of operators, condition and kind of materials, etc., results in spoilage and rejects which tax production and profits. Infinitely variable speed control for each machine overcomes this handicap.

RESTRICTED MACHINE OUTPUT

Wrong machine speeds impose a tax on production volume and profits. With REEVES Variable Speed Control you can speed up or slow down each machine to the exact rate of production that provides the biggest output without sacrifice of quality.

WASTE OF TIME

When employees have to wait for materials on conveyors that are moving too slow, or on machines with incorrect speeds that do not synchronize with others, another unnecessary tax is placed upon production and profits.

LACK OF UNIFORMITY

Constantly varying conditions, in plants and in materials, make it next to impossible to turn out the same quality of production hour after hour and day after day unless machine speeds are variable, too.

LOWERED QUALITY

Quality is frequently lowered because inflexible machine speeds make it impossible to meet exact specifications of manufacture. Orders are lost or profits are sacrificed. Variable Speed Control avoids this tax on sales and profits.

SCHEDULE FAILURES

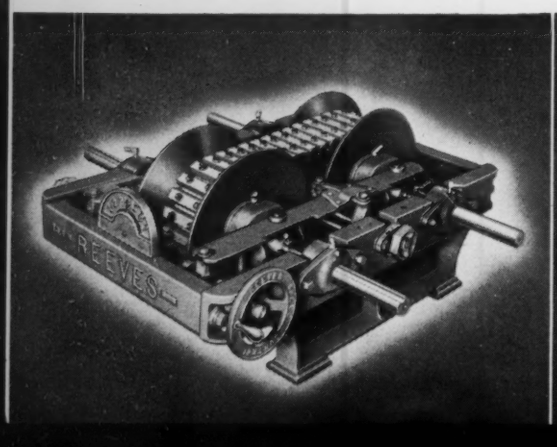
A one-speed machine will do just so much, and no more, regardless of work schedules and shipping dates. With REEVES Speed Control each machine in the line can be speeded up in emergencies, to avoid the penalties of cancelled contracts and missed orders.

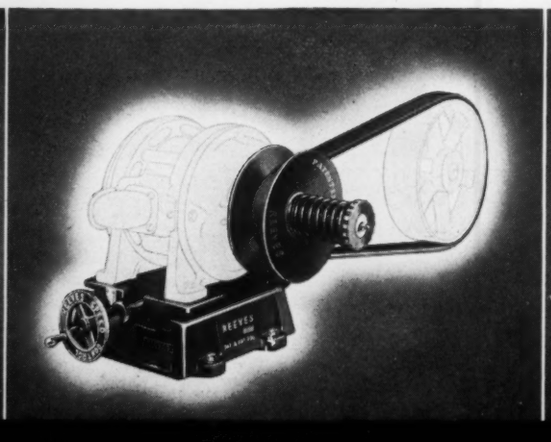
THE 3 BASIC UNITS IN MODERN REEVES LINE

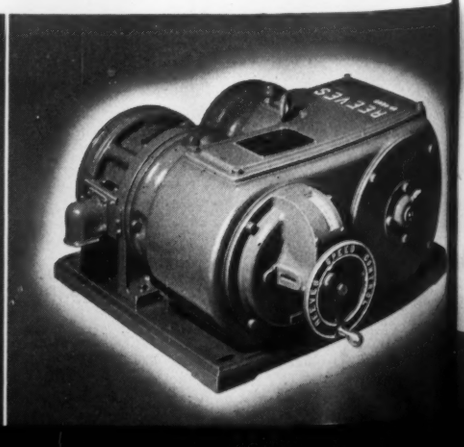
REEEVES VARIABLE SPEED TRANSMISSION—Provides infinite speed adjustability over wide range and for heavy duty service. Accurate and positive at all speeds. Modern open and enclosed designs, vertical, horizontal. Fifteen sizes—fractional to 125 h. p. Speed variations 2:1 to 16:1 inclusive.

REEVES VARI-SPEED MOTOR PULLEY—Simplified development of Transmission. Mounts on standard shaft of any constant speed motor. Forms direct drive to machine. For light horse power requirements up to and including 15 h. p. and not greater than 3:1 ratio of speed range.

REEVES VARI-SPEED MOTODRIVE—Combines in one compact, self-contained enclosure, constant speed motor, REEVES speed varying mechanism and reduction gears (where required). In space-saving horizontal and vertical types—¼ to 10 h. p. Speed variations 2:1 to 6:1 inclusive.







THAT MANUFACTURERS *Don't Have to Pay* WHEN MACHINES ARE REEVES-EQUIPPED

THERE are taxes—and taxes. Here are some your customers shouldn't have on their lists.

Spoilage of materials and products, restricted machine output, waste of time, lack of uniformity, lowered quality, and schedule failures—*all constitute taxes on production and profits* which may be eliminated entirely or substantially reduced by the application of correct speed control.

REEVES Variable Speed Control provides instant, accurate, positive, and inexpensive adjustability of machine speeds to meet all changes in work schedules, conditions in plant or materials, size, weight, or shape of products. If your machines are among the 1324 different types which are so equipped *all* of these advantages may be enjoyed, and the penalties avoided, by your customers. Send for copy of 124-page catalog G-384, which describes the complete REEVES line, and tells how it is cutting costs and improving processes in 18,000 industrial plants.

REEVES PULLEY CO., *Dept. H,* **COLUMBUS, INDIANA**

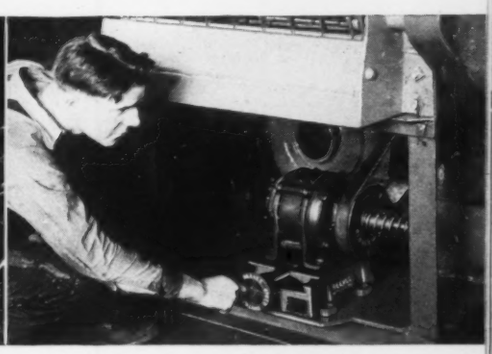
Above—Extruding machine, equipped with REEVES horizontal enclosed design Variable Speed Transmission.

•

Right—REEVES vertical design Vari-Speed Motodrive on grinding machine.

•

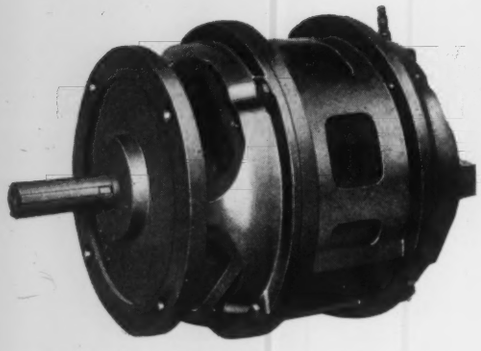
Extreme Right—REEVES Vari-Speed Motor Pulley installed on metal parts washing machine.



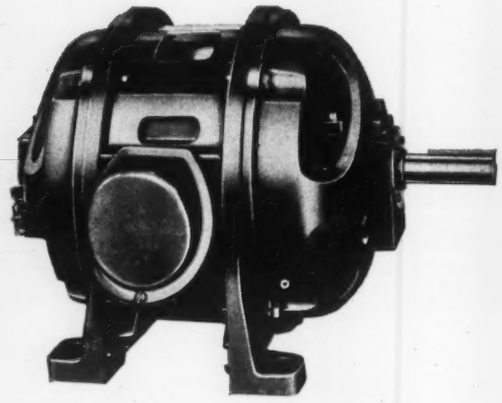
A COMPLETE LINE OF EQUIPMENT—
BACKED BY A NATION-WIDE ENGINEERING SERVICE

Reeves SPEED CONTROL

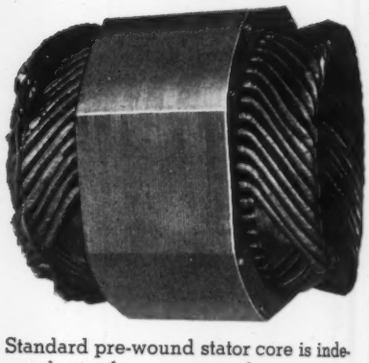
"SPECIAL" DESIGNS WITH "STOCK" DRIVES



Type B Flange Mounting . . . rigid one-piece frame supports the motor.

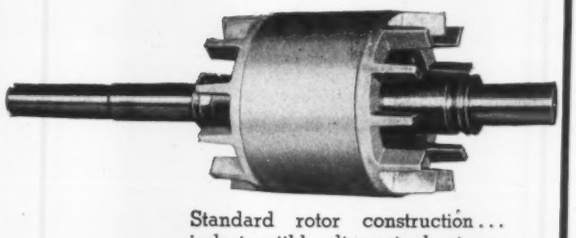


Standard one-piece frame gives extra mechanical strength at no extra cost. Electrical parts are free from mechanical strain from bearings and shaft.



Standard pre-wound stator core is independent of supporting frame . . . fits standard frame or built-in applications.

WESTINGHOUSE STANDARD DRIVES AND INTERCHANGEABLE ASSEMBLIES SOLVE MANY SPECIAL DESIGN PROBLEMS



Standard rotor construction . . . indestructible die-cast aluminum.

NEW MANUAL STARTER TAKES LESS SPACE

An economical starter that is especially designed for mounting on machine or motor in minimum space. For motors up to 7½ hp. Keeps motor control within arm's length of the operator.

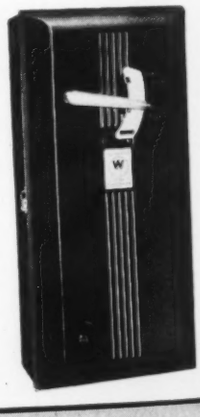
"DE-ION" MOTOR WATCHMAN

COMPLETE CONTROL IN ONE PACKAGE

One unit provides all needed devices in the motor circuit:

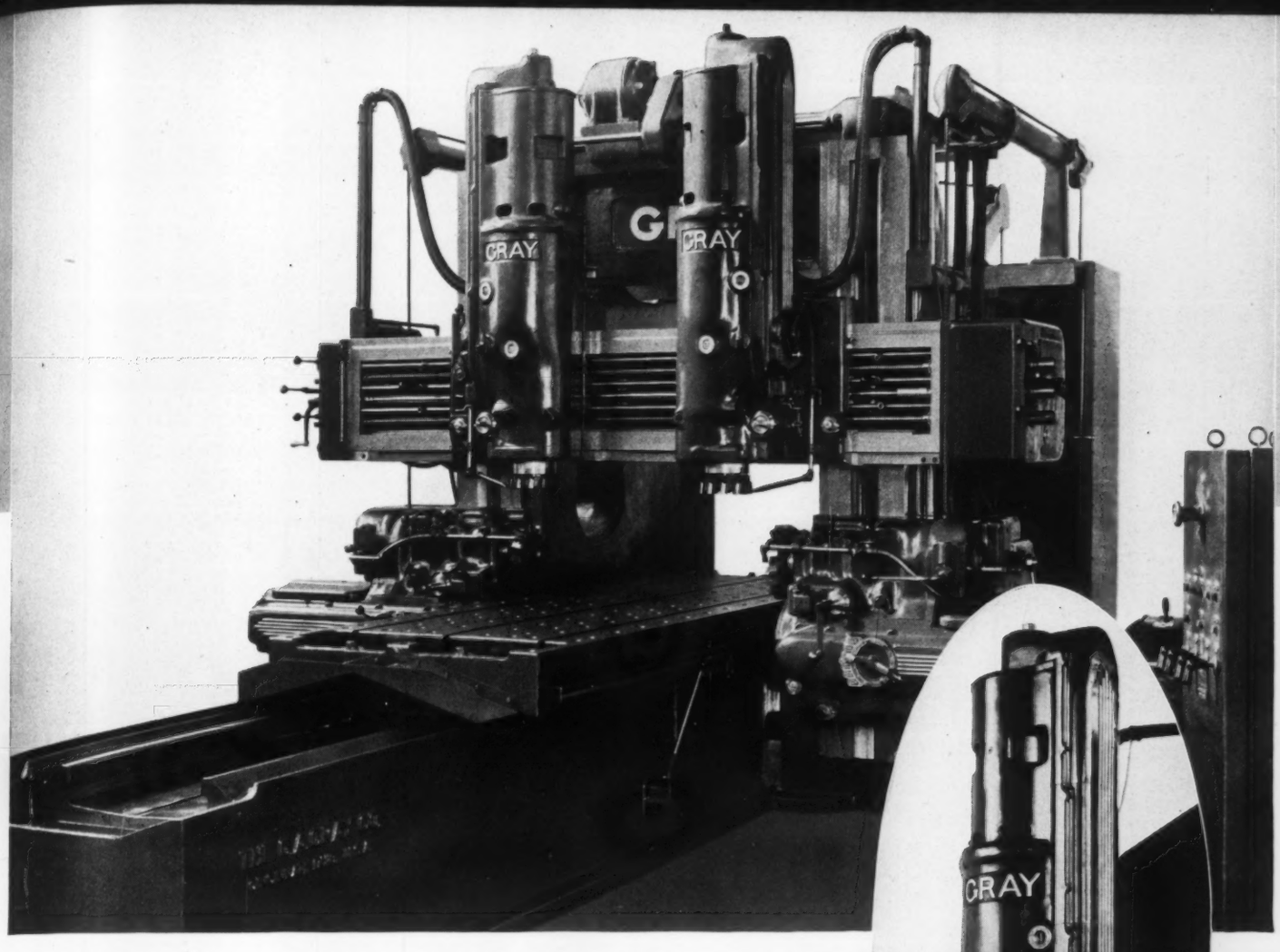
1. Magnetic starter
2. Motor overload protection
3. Manual disconnect switch
4. Fuseless circuit protection

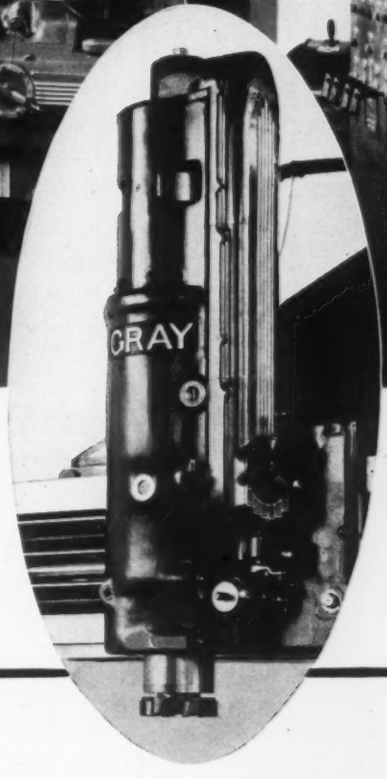
COMBINATION LINESTARTER



Westinghouse

WESTINGHOUSE ELECTRIC





18 SPINDLE SPEEDS ON THE NEW GRAY MACHINE OBTAINED WITH STANDARD WESTINGHOUSE MOTORS AND CONTROL

Designers of the new Gray Planer Type Milling Machine wanted *push-button control,* wide flexibility and maximum rigidity.

All three are accomplished in the most economical manner by the use of 9 individual Westinghouse motors, giving finger-tip control and maximum flexibility. And the substitution of these individual drives for long drive shafts results in greatest possible rigidity.

The machine is an outstanding example of how Westinghouse can meet special requirements from stock motors and controls.

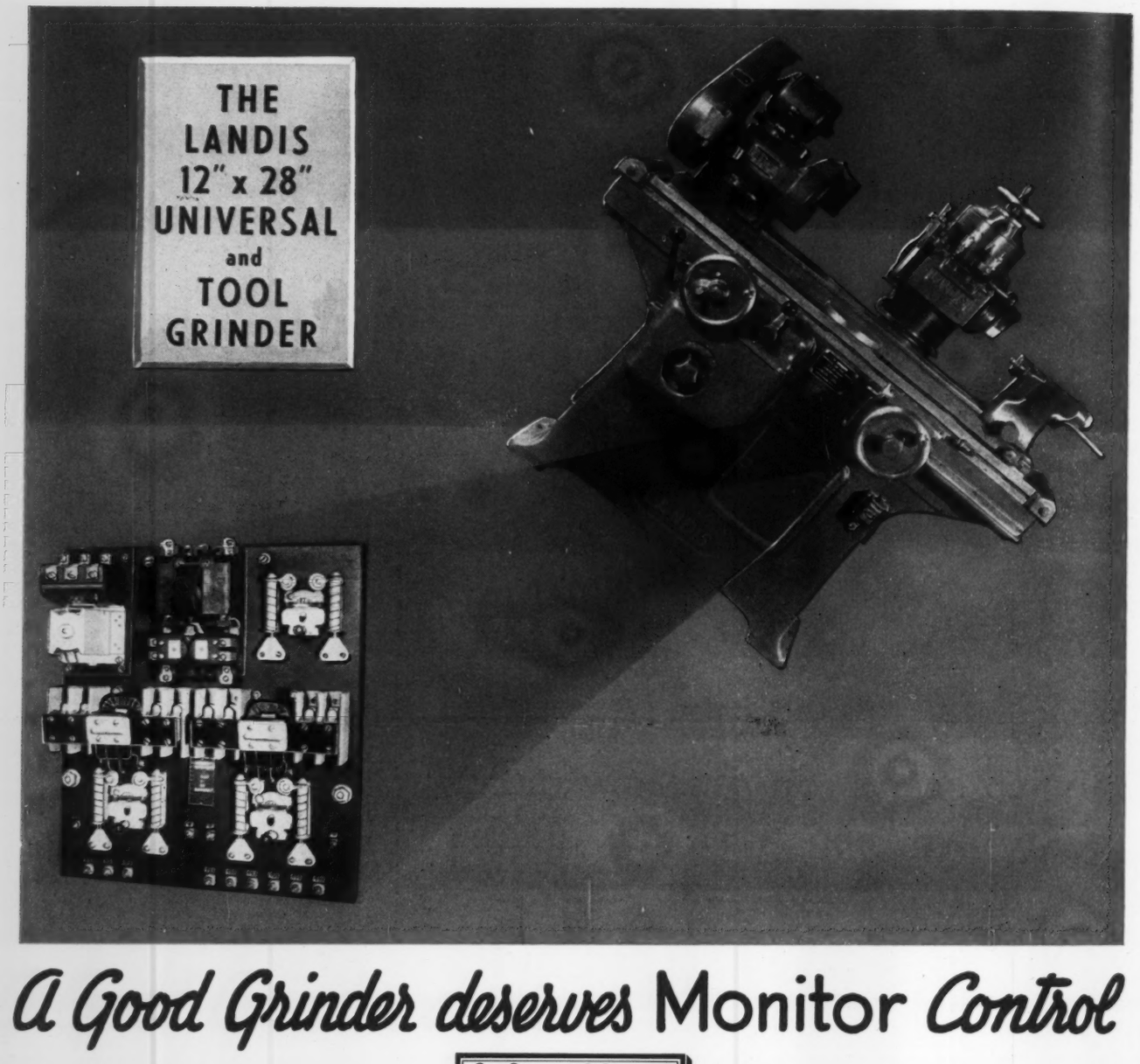
Our engineers are at your service in similar drive problems. Call the local office, or write Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Address Dept. 7-N.

J-90189

Westinghouse Standardized Drives on this machine include:

4 — 10 hp 900 to 1800 rpm spindle drives, 2 speeds.
1 — elevating motor.
1 — table feed gearmotor.
1 — table traverse motor (high speed).
1 — lubricating pump motor.
1 — coolant pump motor.

Motors and Control



A Good Grinder deserves Monitor *Control*

BY BUILDING dependability into its control equipment, Monitor has aided the Landis Tool Co. to build dependability into its grinders . . . For it is a fact well known to every machine tool manufacturer that no machine tool can possibly operate more reliably than the electrical equipment which controls it.

On the grinder and control shown above, provision is made for operation of the work drive motor, the wheel drive motor, the coolant pump, and, if desired, a blower motor — all compactly mounted on the same panel . . . **IT WILL PAY YOU TO SPECIFY MONITOR AND BE SURE OF GETTING OUT OF YOUR MACHINE ALL THE RELIABILITY YOU HAVE BUILT INTO IT . . .** Monitor engineers are at your service for consultation on your control problems. Write us.

Monitor
The Original JUST PRESS A BUTTON System

AUTOMATIC ELECTRIC MOTOR CONTROL

Monitor builds standard controllers, starters, and accessories, also custom-built apparatus for any electric motor control problem, no matter how complex. Monitor sales engineers in principal cities will gladly consult with you.

Monitor Controller Company

BALTIMORE • • • MARYLAND

YOU GET 18 ounces IN A DUMORE POUND

True, motors aren't sold by the pound. But you get "fuller measure" when you buy Dumores. Through painstaking precision practices, many of them exclusively Dumore, "plus" life of trouble-free service is built in. Dumore methods, perfected over a period of 25 years, include: Dynamic balancing of armatures to assure vibrationless running; grinding commutators concentric with bearings to guarantee longer brush life; expanding of windings at high speed, then sealing, to prevent centrifugal "breathing"; swaging armature leads to commutators by special process to accomplish 100% electrical contact; 5-time inspection during manufacture; running-in every motor to seat brushes properly. Get all you pay for... and more. Put your power problem up to Dumore engineers... specialists in AC-DC motors ...1/500 to 2/3 h.p... 0 to 60 cycles. Write today.

THE DUMORE COMPANY
Dept. 129-D **Racine, Wisconsin**

In grinding Dumore armature shafts a nominal tolerance of only .0002" minus is allowed, but for selective bearing fit nearly 90 percent of them are held to the high limit.

SPECIFICATIONS TYPE H MOTOR

Series {Universal} 0-60 cycles; h.p., 1/50; full load speed, 6500 r.p.m.; volts, 115; amperes, .39; watts input, 41.5; duty, 30-minute; temperature rise, 55° C.; housing, totally enclosed; bearings, self-aligning sleeve; housing material, pressed steel; wt., 1-3/4 lbs.

DUMORE MOTORS

FOR Extra POWER HOURS

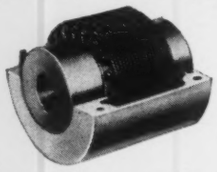
MORSE

FLEXIBLE COUPLINGS and UNIVERSAL DRIVE SHAFTS

There's One for Every Need

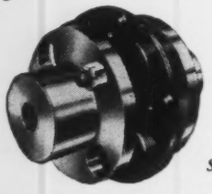
Here's a complete line of flexible couplings and drive shafts, designed by Morse to fill every driving need. They differ in design, construction, and application—but every Morse coupling and drive shaft has the same characteristics of dependability, strength, long service, and high efficiency.

Standard COUPLING



This famous Morse coupling consists of two facing steel sprockets wrapped in a length of special Morse coupling chain and enclosed in a machined split aluminum grease-tight case. The multiple links of the flexible chain acting on the teeth of the sprockets form the flexing medium of this sturdy, silent, efficient coupling. Easy to connect and disconnect—a single pin does the trick. Machined faces of case make installation and alignment a simple matter.

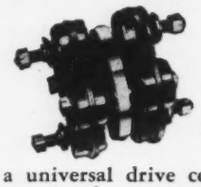
Morflex COUPLING



Series R

The Morflex Coupling consists of two steel hub members and a floating center unit assembly to which each hub is separately connected. This center unit is made up of a two-piece riveted pressed steel housing and four resilient rubber trunnion blocks 90° apart, through which the connecting bolts pass. Thus, in the Morflex, there is no metal on metal movement, and the resilient rubber allows for maximum distortion without loss of efficiency. No protection from dirt, dust, or water is necessary for the Morflex.

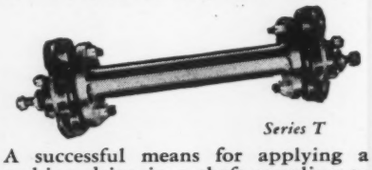
Morflex UNIVERSAL COUPLING



Series CC

Where a universal drive connection or compensation for extreme misalignment is necessary, this is an ideal coupling. Two standard Morflex center members are supported through a center plate secured by through bolts. Three types of companion flanges.

Morflex TUBULAR UNIVERSAL DRIVE SHAFT



Series T

A successful means for applying a cushion drive in a shaft coupling to units of remote or angular location. Frequently used with Gas or Diesel power plants as an accessory drive. Smooth, quiet, and efficient in operation. Small sizes have solid shaft; shaft is tubular in larger sizes.

MORSE CHAIN COMPANY

Division Borg-Warner Corporation

ITHACA, N. Y. • DETROIT, MICH.

Data sheets with full specifications are available on all the above. Call in the nearest Morse representative or write direct to Morse, Ithaca.

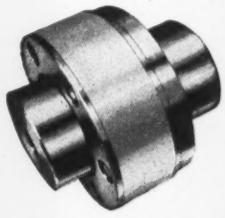
Morflex UNIVERSAL DRIVE SHAFT

LONG AND SHORT COUPLED

Series S and ST

Features slip joint construction, is applicable when end float and full universal action is necessary to accommodate angular or parallel misalignment. Shaft members are of full spline construction and slide freely under load. Lubrication is sealed in the spline joint. Morflex drive shafts transmit no noise or vibration.

Morflex RADIAL COUPLING



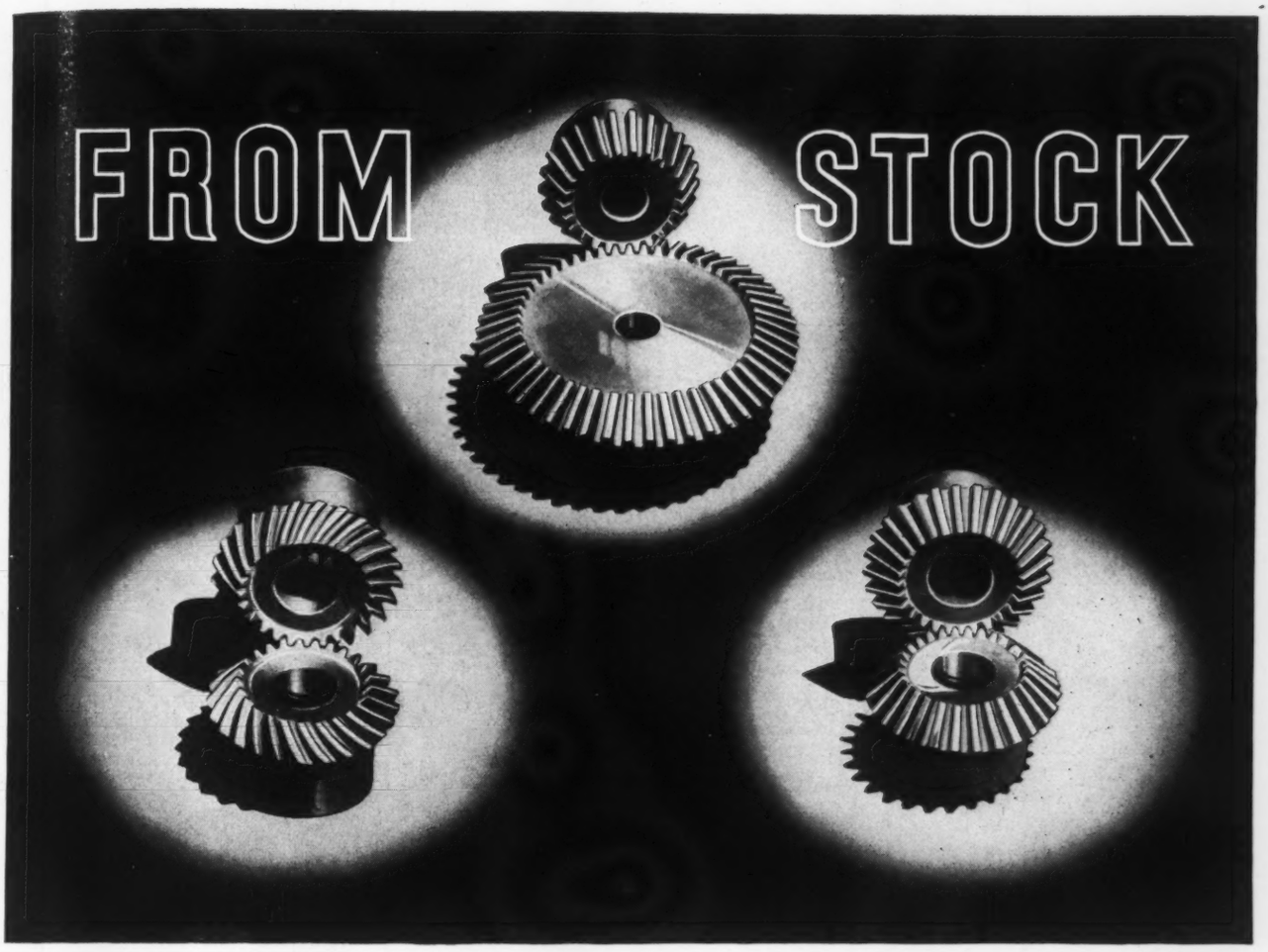
In the Morflex Radial coupling, specially shaped rubber trunnion bushings are assembled radially, equally spaced, on the steel pins of the yoke or hub member. A two-piece metal housing encases the rubber blocks and provides for bolting the companion flange. The entire unit is machined for perfect balance. No metal on metal movement. The long-wearing non-cold flow rubber blocks withstand shock loading, dampen vibration, and compensate for misalignment.

Morflex RADIAL COUPLING DRIVE SHAFT

LONG AND SHORT COUPLED

Series RS and RT

The flexibility, quietness, and cushion drive features of the Morflex Radial construction are ideal for many industrial coupling applications when a coupling shaft of considerable length is required. The sliding spline provides endwise movement freely under load and the tubular shafts of proper dimensions eliminate whip and vibration within rated speeds. Drive shaft lengths and flange adaptions supplied to customer's requirements.



CONSIDER THESE ADVANTAGES
when specifying bevels and miters

1 Boston Gear bevels and miters are carried in stock for your convenience by 75 distributors and direct factory branches.

2 Boston Gear bevels and miters are quality products; they are made of the finest materials; the most up-to-date manufacturing methods are used and all Boston Gear bevels and miters are subject to very rigid inspection during their manufacture.

3 Boston Gear bevels and miters are manufactured in large quantities, hence their cost to you is less than corresponding made-to-order products.

BOSTON GEARS

BOSTON GEAR WORKS, INC., NORTH QUINCY, MASS.

To: BOSTON GEAR WORKS, INC., NORTH QUINCY, MASS.

Please send.....copies of your General Catalog No. 52 containing complete specifications and list prices of 134 different sizes of Boston Gear bevels and miters available from stock.

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Firm.....

Street.....

City.....State.....

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INDIANAPOLIS
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335 Postal Station Bldg.
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Machinery Co., Inc.
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No matter where your plant is located, there is a "Logan" Representative near you. He is qualified to render you valuable assistance in applying air and hydraulic equipment to your particular operations. And he brings you a complete line which meets your every requirement.

Call on your nearby "Logan" Representative freely. He will be glad to serve you.

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911 PAYSON ROAD LOGANSPORT, INDIANA
Manufacturers of Air and Hydraulic Devices, Chucks, Cylinders, Valves, Presses and Accessories

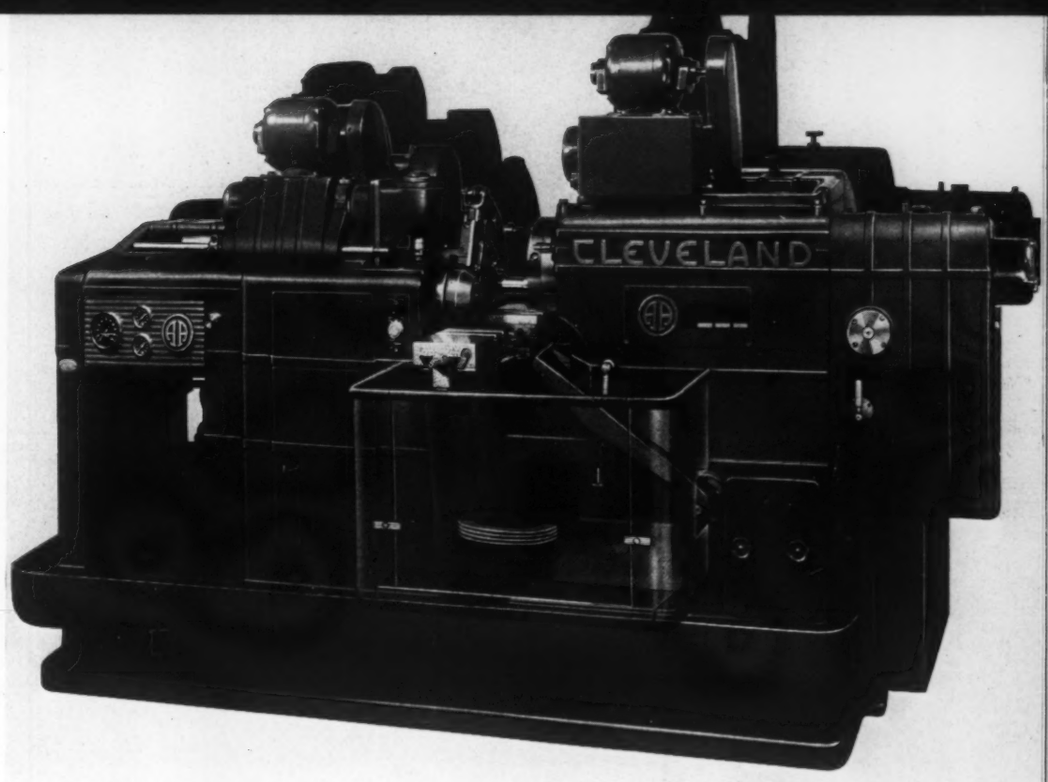


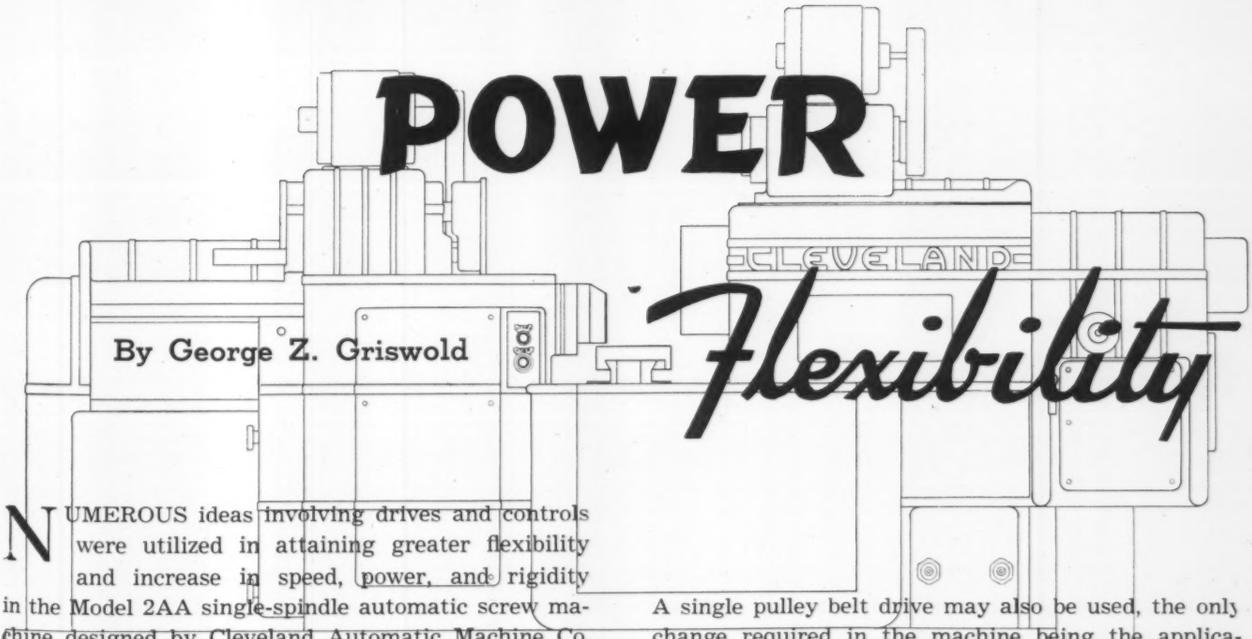
Fig. 1—View of machine with attachments mounted over spindle head and tool turret housing. Functional purposes and modern styling were blended in the exterior

ATTAINING .....

SPEED

POWER

Flexibility



By George Z. Griswold

NUMEROUS ideas involving drives and controls were utilized in attaining greater flexibility and increase in speed, power, and rigidity in the Model 2AA single-spindle automatic screw machine designed by Cleveland Automatic Machine Co. and shown in *Fig.* 1.

One main motor of 7½-horsepower, 1750 revolutions per minute, drives the machine proper, separate motors being used for the attachments over the tool turret and the spindle head, to be discussed later. A single pulley belt drive may also be used, the only change required in the machine being the application of a pulley assembly to the motor plate instead of the motor. Each motor is protected from overload by a protective device which shuts down all motors simultaneously.

From the main motor in the rear of the machine

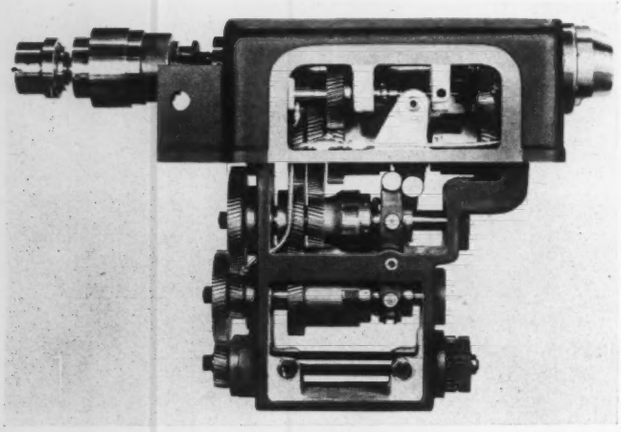


Fig. 2—Cutaway view of spindle head showing gears for three speed ranges, obtained by changing sprockets on drive shaft and low spindle head shaft

power is transmitted by V-belt to the drive shaft and thence by chain drive to the gears in the spindle head. Spindle head parts are fully enclosed in a single casting which is rigidly mounted to the one-piece cast bed.

Fig. 2 is a cutaway view of the spindle head, in which three ranges of spindle speeds are available. Ranges are secured by changing the sprockets on the drive shaft and the first spindle head shaft. Actual spindle speeds—36 fast or slow forward and 36 reverse—are obtained by change gears. For any one setting high and low forward speeds and a low speed reversal are secured automatically in any desired sequence. Ratio of the reverse speed to the low forward speed is one and one-tenth to one.

After lengthy investigation, shaved gears of S.A.E. 4150 steel with a brinell hardness of from 302 to 331 were found desirable. They represent unusual durability and accuracy for these gear drives and are heat treated before final machining. Splines are used for mounting gears and are ground to insure concentricity of pitch line and shaft center.

Spindle Bearings Preloaded

To preclude chatter and to gain cool operation over the increased speed range, an entirely new principle of preloading spindle bearings was developed in cooperation with a leading bearing manufacturer. This development, along with the modern box construction of the machine, provides the smoothness and rigidity required by high speeds.

Metallic friction clutches with steel and bronze plates change and reverse spindle speeds, controlled by quick-acting "load-and-fire" clutch shifters. Spindle head shafts are S.A.E. 4140 chromium-molybdenum steel. Forged spindles are S.A.E. X-1335 medium carbon, high manganese steel, annealed, normalized and heat treated in the rough so that distortion is avoided. Reversal of the spindle at high speed is positively locked out.

The entire machine is lubricated automatically and in the case of the spindle head gears, high pressure jets of oil are directed into gear meshes, the rest of the interior of the spindle head being lubricated by spray created by gear action. Fresh oil only is fed constantly to the main spindle bearings, and the oil outlet is vented to the gearcase. The whole lubricating system is collected, with the coolant distributing pump, into a convenient unit assembly at the spindle end of the machine.

The friction roll used on previous machines has been superseded by an infinitely variable speed transmission unit located at the rear of the machine. No adjustment of this unit is required and feed changes are obtained promptly with light operating pressure. All feed changes, as well as the change from feeding to index speeds and vice versa, are secured automatically through two independent lever control mechanisms. Both of these control mechanisms are set and operated from a regulating wheel on the camshaft.

The feed and indexing mechanism, partially exposed in *Fig.* 3, is driven from the driveshaft which starts at the motor at the spindle head end of the machine and terminates in a bevel gear at the feed end. Drive is split at this point into two drives. One of these is geared to the variable speed transmission which transmits power to the feed range gears, through overrunning clutch, and a hand-control clutch to the main worm. The latter controls the turret operating drum and also the camshaft.

Through a chain drive and connection, an indexing

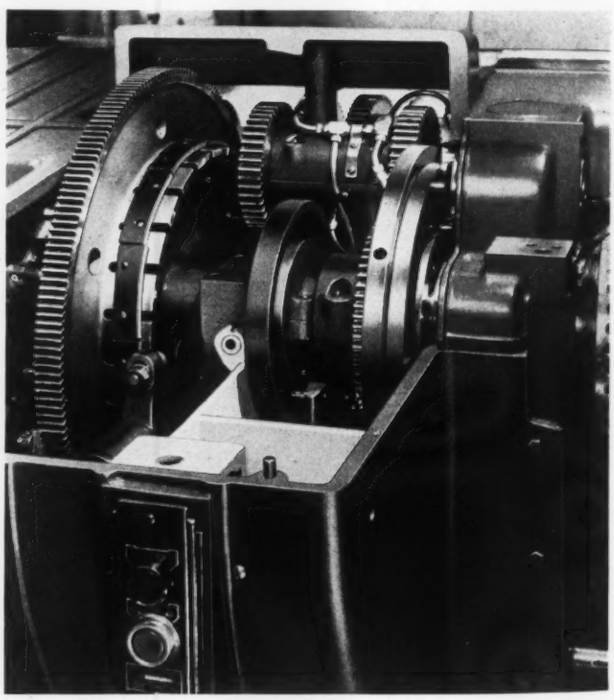


Fig. 3—Feed drive mechanism partially exposed. One of two pushbutton stations is shown. Feed changes are obtained automatically through independent controls

speed clutch, and a hand clutch, the other drive goes into the worm and wormwheel drive again. This drive runs at a constant speed, representing the idle or indexing speed of the machine. When the idle motion clutch is engaged, the high speed drive "runs away" from the slow feed drive through the overrunning clutch. When this clutch is disengaged, however, the overrunning clutch slows down and picks up at whatever designated rate of feed has been set on the variable transmission.

Stock-feed and chucking mechanisms are located immediately back of the spindle head and are supported by a column at the end of the machine, built up from the pan and supported by connection with the bed. To secure balance of the spindle and relieve it of strains from the whip of the stock, a simple, rigid antifriction mounting is incorporated in the stock-feed tube support. Both chucking and stock mechanisms have been designed for balanced and high speed operation and are operated by heat treated aluminum alloy cam drums instead of segments as formerly. Thus double-camming can be secured to permit production of two pieces per cycle where operations allow.

Round Tool Turret Retained

The conventional Cleveland round tool turret has been retained, using six tool turret holes, a large bearing completely surrounding the turret for support. A three-roll indexing head and specially shaped accelerating and retarding cams index the turret and locate it at rest before the turret wedge enters the spline.

A single heavy camshaft, supported in arms cast integrally with the bed of the machine, times all operations. When used, attachments are also timed directly by the same camshaft.

Attachments fall into four general kinds, the machine being adapted to receiving any regular attachment without change: (a) Attachments to feed stock from magazines; (b) high speed drilling attachment, drilling before the piece is cut off the bar; (c) attachments performing operations on the work after it is cut off the bar; (d) miscellaneous groups.

The attachments operating on the cutoff end of the work are of particular interest. To receive and drive any of the whole group of attachments, a separate standard motorized unit is supplied, shown in *Fig.* 4. This is mounted over the spindle head. Speeds of the attachment are controlled through change gears and feed is controlled through an auxiliary drum driven and timed from the camshaft. The drive unit terminates at a splined socket in the flanged face of the motor unit to which the attachments proper are fastened. This separation of the motor unit from the attachment makes necessary the purchase of only one drive unit, and considerable saving in setup cost is made because only the attachment proper need be changed over.

High speed drill spindles are received in any hole of the tool turret and moved forward at feeds determined by the turret. From the attachment, mounted over the turret, a chain connects to a sprocket surrounding the central turret shaft. Drive thence goes to a central gear attached to the sprocket and rotating about the central turret shaft, this gear in turn acting as driver for the gear on the high-speed drilling spindle. In this way spindles may be located in adjacent holes. Variations in the high-speed drilling speeds are obtained by pick-off gears in the attachment drive so that the proper drill speed is maintained within close limits in connection with the work spindle speed.

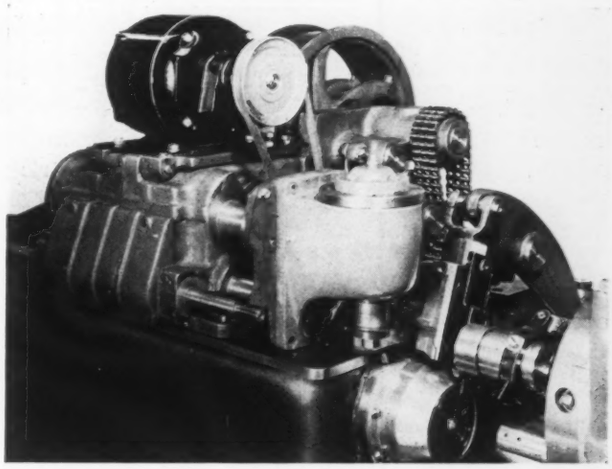


Fig. 4—Attachment mounted over spindle head. This drives from its own motor, feed being controlled through auxiliary drum in rear, driven and timed from camshaft

The machine and attachments are controlled from front or rear through two pushbutton stations, to run, jog, or stop. Although the machine can be run or jogged from either front or rear, as a safety measure both buttons must be turned to "run" before it can be run continuously from either point. Hence if the operator is in the rear and wants the machine only to jog, no other person can change it to run by merely pressing the front button.

Controls Collected in Unit

All controls for electrical equipment have been collected into one unit assembly and mounted at the end of the machine in a separate box which can be locked to prevent tampering. A pressure switch in the box cuts out and stops the machine when lubricating pressure drops to a dangerous point. To step down line voltage to 110 volts for operating controls for alternating current motor drive, a transformer has been provided.

(*Concluded on Page* 62-S)

Fig. 1—Small space, light weight, high speed requirements are performed by shell-type motors

When to U

INCREASING use of built-in motors is not the result of attempts to substitute electromagnetic parts for complete motors, but rather to refine machine design by motorizing directly a machine function. Many designers prefer to specify electric wires from point to point rather than a train of gears or mechanical rods and levers. Also, the steadily increasing spindle speeds and decreasing cycle time are necessitating the refinement of functions of machines. In so doing the advantages of built-in motors become more and more important.

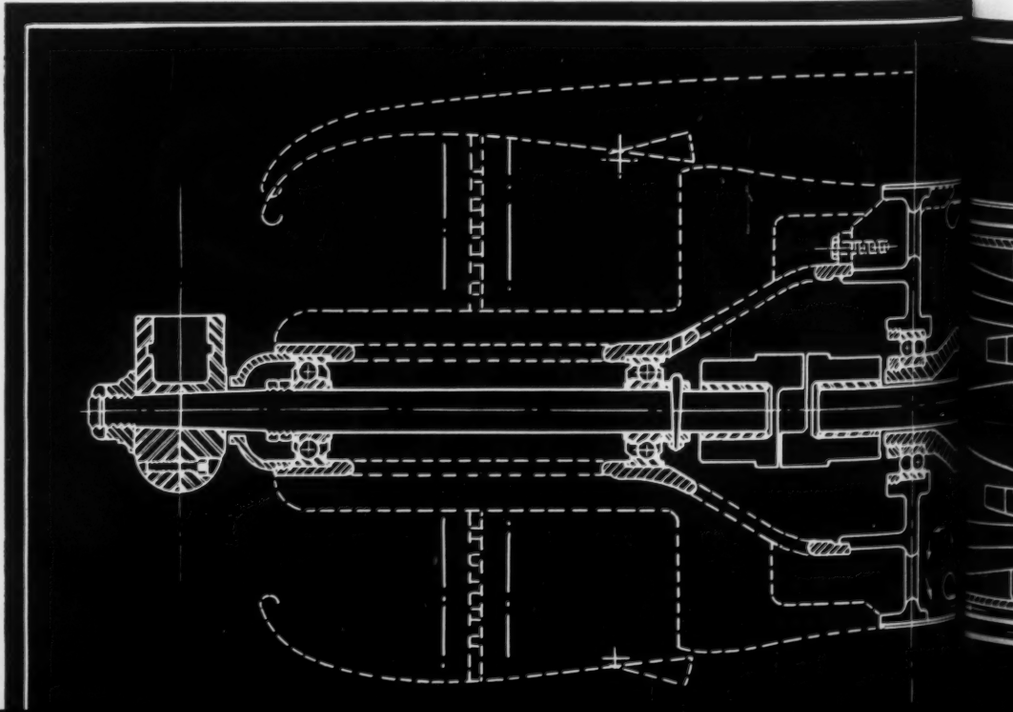
One of the most useful of built-in motors is known as the shell-type. Even though this type of motor is stressed in the following, however, it should not be forgotten that modifications of standard motors, complete or partial, can be built in or built on a machine, sometimes with greater economic advantage than can the shell-type motor.

From the user's point of view, these motors might be defined as the electrical parts of a polyphase or single phase squirrel cage motor without mechanical parts other than stator and rotor, without ventilation, lubrication, final balance, proper assembly, or consideration of accessibility. In other words, shell-type motors represent a transfer of responsibility normally assumed by motor manufacturers to the machinery manufacturer. This is the price paid for the increased flexibility offered by these motors, and should be an important item whenever use of built-in motors is considered. Close co-operation between the motor maker and the motor user, however, enhances the probability of successful application.

But what are the distinguishing features of shell-type motors that make them advantageous and convenient to use? The most outstanding is that three and sometimes as many as six different continuous horsepower ratings are built in each of the six principal shell diameters. Thus large horsepowers are available in small diameters and many parts developed by a machinery manufacturer are common to different motors. Different horsepowers are obtained by greater lengths. These lengths as well as diameters and other dimensions recently have been standardized by the various motor manufacturers.

Another consideration is the exactness of dimensions to which these motors are built. For example, shell diameters are machined to a tolerance of plus .002-inch. Exact concentricity of stator shell, stator bore, rotor periphery, and rotor bore is important to facilitate obtaining uniform air gap in assembled motors. As a matter of fact, a 10 per cent final variation of air gap should not be exceeded.

Now let us consider the conditions which justify the use of shell-type motors and the major applications in which they have been put to use. Generally, when an application demands a large number of special features it may be that a lower overall machine cost or a vastly improved machine would result if the motor were considered as an integral



By O. F. Vea
General Electric Company

to Use the Shell-Type Motor

part of the machine rather than a separate unit.

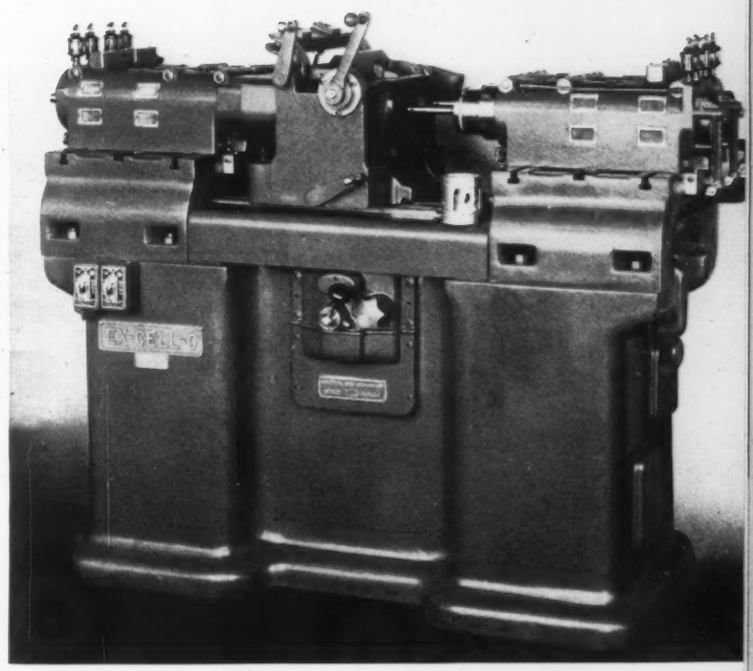
These special features might be divided into two broad classes: (1) Those involving limitations of space and peculiar shapes and (2) those involving unusual dynamic problems.

Specific conditions together with examples where the use of shell-type motors might be justified are discussed in the following.

Where High Speeds Are Required

Speeds higher than 3600 revolutions per minute are sometimes advantageous. Higher speeds are not available with 60 cycles but are possible with higher frequencies supplied by frequency converters. Carving machines, routers, shapers and other woodworking machines were the first to use high frequency motors. Later, grinders, drills, wire straighteners, dessicators and the like utilized them.

For this condition of high frequency, both space limitations and "dynamic co-ordination" justify shell-type motors. Smaller torques per horsepower at the higher speeds create the possibility of reducing motor sizes below normal. A large output with a small



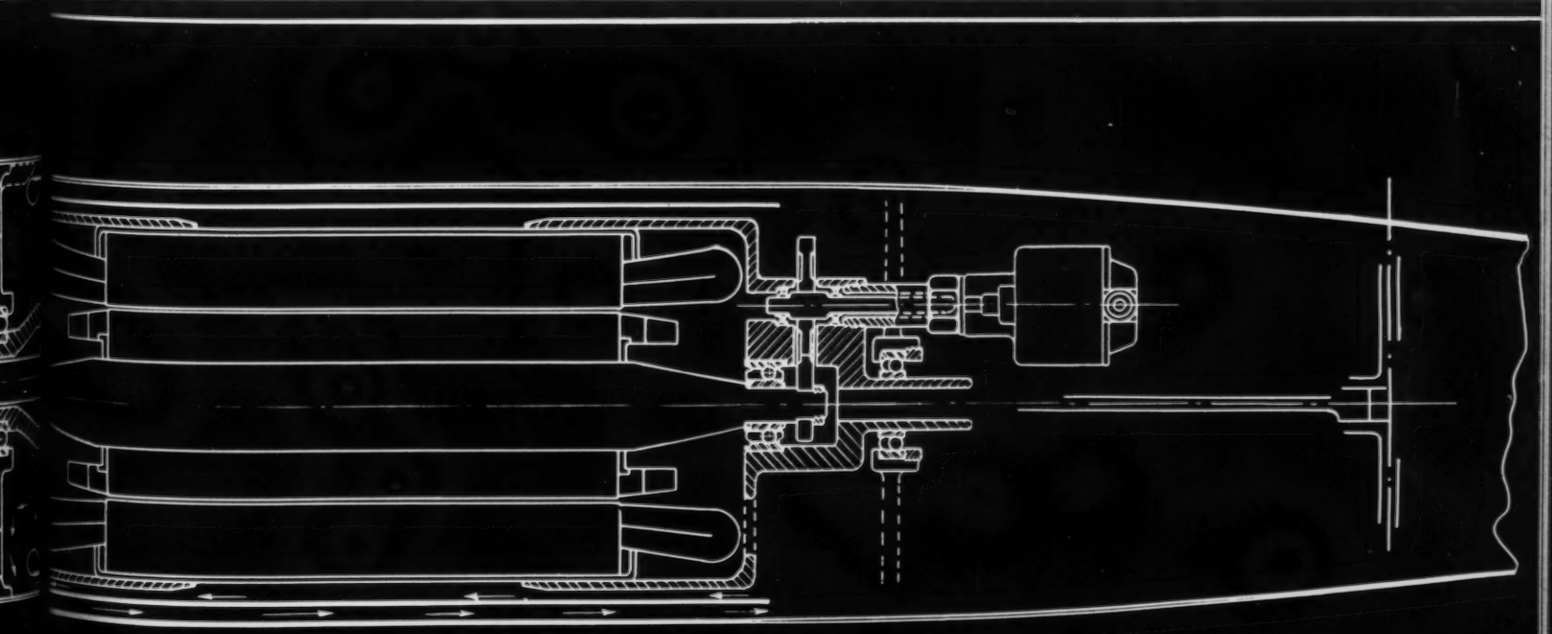


Fig. 2—Above—Small diameter motors provide close spindle locations on boring machine. Fig. 3—Below—Specially built streamlined motor for wind tunnel tests

carcass is possible with special ventilation to dissipate the losses.

Of greater importance is dynamic co-ordination. Vibration, bearing design and lubrication are problems at these high speeds. A motor as a separate unit, complete in itself, is not feasible for attaching to the driven machine. It and other mechanical parts must be made as one compact, integral unit for most successful results. Critical vibration points on the way up to speed or at full speed may have disastrous results insofar as mounting or mechanical parts are concerned. Excessive vibration

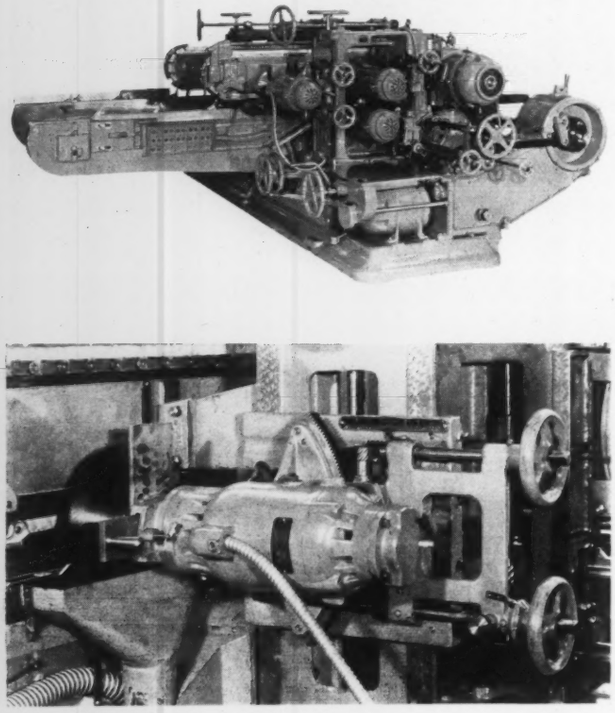


Fig. 4—Top—Double-end tenoner meets space limitations with shell-type motors. Above—Effective diameter of saw increases with small diameter motor

also would increase the load on the bearings and shorten their life.

High speeds increase bearing losses and necessitate lubrication, either of a positive feed type or an oil mist method. Flexible shafts and relatively loose bearings in some cases permit rotating equipment to seek its own center of rotation and prevent harm from criticals. However, this would not give the precision necessary for cutters and grinders. For these applications, short shafts, precision oversize bearings, excellent balance and positive lubrication are essential. All these requirements are special and therefore shell-type motors have a definite place in high frequency applications.

Savings in space and weight with high-speed motor operation is particularly advantageous in portable hand tools and small group spindle drives such as drills, grinders, polishers and carvers. Many manufacturers take advantage of the smaller motors and the lighter weight for maximum output as well as the better work which the higher speeds generally produce. The carver shown in *Fig.* 1 illustrates how small space and light weight requirements were achieved with high-frequency shell-type motors. There are twelve ½-horsepower, 10,800 RPM motors on the spindles of this multiple-spindle carver.

When Space Is Limited

Compactness is important in good design. It generally can be associated with a high degree of simplicity and light weight. Sometimes diametral limitations preclude the use of standard complete motors. The shell-type motor characteristic of large horsepower in small diameter, previously mentioned, answers this need.

Motor designers have long related horsepower output of a motor directly to its size. Volume is directly proportional to the length and the diameter squared. Thus, keeping diameter the same and increasing length makes possible larger horsepowers in one diameter. This method of increasing horsepower is not the most efficient because it takes more length than diameter to increase the horsepower by the same amount. Though uneconomical from a motor standpoint alone it can be justified in some applications.

An example where small diameter is important is when motors are mounted closely to a wheel or working tool. Grinders, saws and the like are typical. The effective working diameter of such a tool is the amount the wheel diameter extends beyond the motor diameter.

Close spindle-center locations on directly driven gang drills, precision borer, etc. is another type of application where small diameters are useful. In many cases, single castings house a multiplicity of shell-type motors. Small diameters are a prerequisite for close spindle location on the multiple-spindle boring machine shown in *Fig.* 2. This machine also requires excellent treatment of bearing lubrication and balance to produce the precision work required of it.

A splendid example of another similar case is shown in the double-end tenoner, *Fig.* 4. Two cut-off saw units, four tenon units and two cope units are of shell-type design to meet the space limitations. These limitations are not imposed elsewhere, so the dado unit uses standard motor parts, and the feed motor is a standard complete motor.

Sometimes surrounding conditions and construction dictate the necessity for a radically unorthodox housing and cooling system. The drawing in *Fig.* 3 shows a motor installed in a model airplane power plant nacelle for wind-tunnel tests. The nacelle contour constitutes the housing and a separate motor-driven fan in the body of the nacelle supplies ven-

tilation. The stator is cradled, too, so that in effect the entire unit is a small dynamometer. Its application is unusual but extremely interesting.

Dessicators, hydrogenizers and atomizers generally operate on high frequencies and must have the rigid short rotating system previously mentioned. This often brings the motor close to high temperatures in the drying tank and, therefore, necessitates highly effective cooling that can only be accomplished with special housings.

Machines Requiring Rapid Reversing

Screw machines and pipe-fitting machines requiring tapping service, reversing lathes and similar applications obtain reversals most economically at speeds of 450 revolutions per minute or higher with direct-connected reversing motors. Advantage is taken of the cushioning effect in the magnetic retardation of the motor to reduce noise which might be caused by mechanical methods of reversing and to decrease wear and maintenance on the machine as a whole.

Each time the motor reverses, an amount of energy equal to approximately four times the kinetic energy of the rotating system at full speed is released and must be dissipated.

This energy is proportional to the physical inertia of the system, or more technically to the WR^2 where W is the weight and R is the radius of inertia.

A long rotor of small diameter will have less effect of inertia than a shorter rotor of large diameter. Thus the special shapes of shell-type motors can be used to advantage to increase the number of reversals possible or to decrease the overall heating of the motor.

Moreover close coupling eliminates additional external WR^2 to further benefit the operation. Reversals at some low speeds of as high as 60 per minute have been obtained. Practically, however, 30 reversals per minute generally more than meet actual duty cycle needs. The reversing lathe shown in *Fig.* 5 is typical of this type of application.

Various Ratings for Same Diameter

Machinery manufacturers know that a single machine properly designed can be used often for vastly different jobs with a change of the driving unit only. In many cases, substituting only a motor of one rating or electrical type for that of another is all that is required. Thus it is that shell-type motors in the 4-spindle drill, shown in *Fig.* 6, extend the field of application of this machine. It is suitable for high speed drilling with a high frequency motor; normal drilling with a four-speed or two-speed, 60-cycle motor; or for rapid reversing tapping duty with a two-speed or single-speed high torque reversing motor.

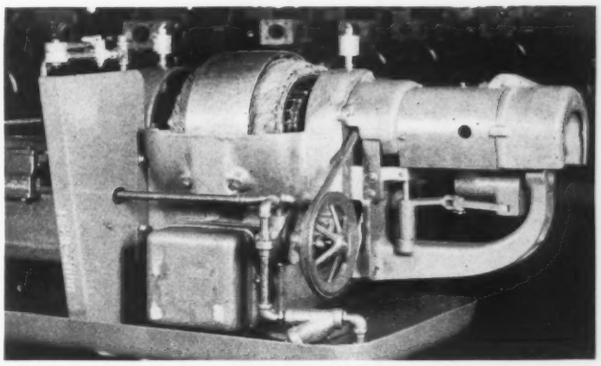


Fig. 5—Inertia in reversing is reduced in lathe with motor on spindle

Every designer has his own ideas as to how to improve machine appearance. Eye apeal and "streamlining" are definite sales features. Extraneous parts can be eliminated and the entire machine appearance improved.

Finally, machinery manufacturers know that if they could control the selection of electrical equipment—as they would with built-in equipment—they could avail themselves of opportunities for refinement in design and for long-desired standardization with resultant improved operation and efficiency. For example, each machine function on a multi-purpose machine could be made a separate unit with its own motor drive properly tailored electrically and mechanically. Thus, effectively co-ordinated with other functions through electrical and mechanical control it would become more automatic.

Through all this, economic justification for use of shell-type motors has been discussed. All of the advantages mentioned must be weighed against the

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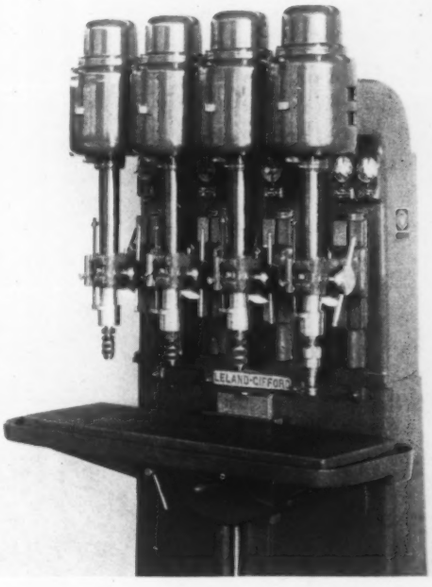
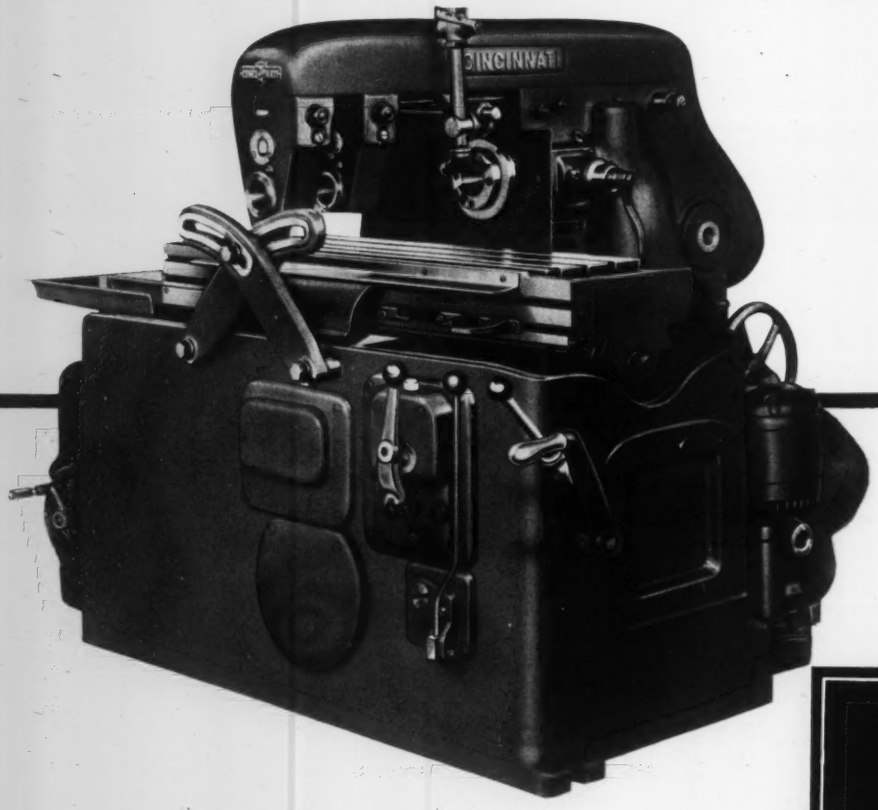


Fig. 6—Same diameter motors but with various characteristics are readily substituted in this four-spindle machine



Hydraulics Ca

By Hans Ernst and
Albert H. Dall

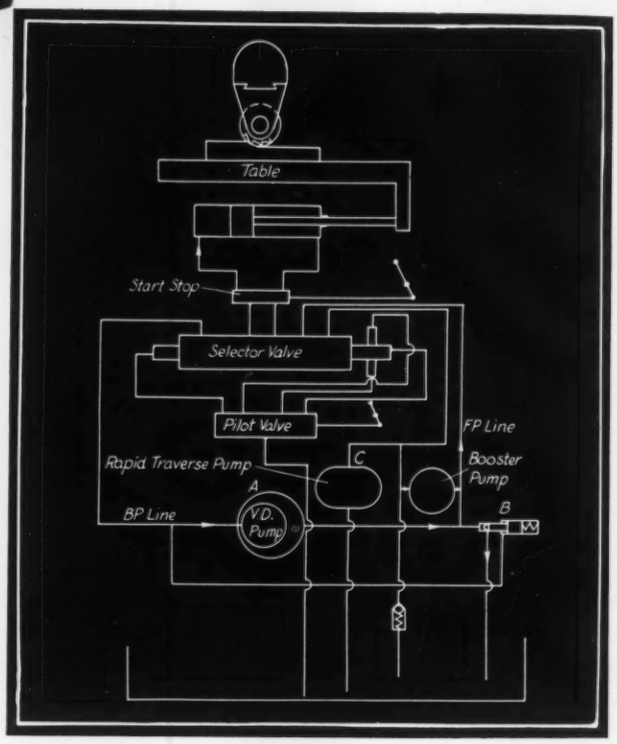


Fig. 1—Top left—Hydraulic unit is located at left of hydromatic bed type milling machine and clearly shows feed rate control lever. Fig. 2—Above—Locked hydraulic circuit, where rate of table movement is controlled by metering oil leaving low pressure end of cylinder through variable delivery pump, locking piston between pressures

APPLICATIONS of hydraulics may be found in almost all fields of engineering today, in sharp contrast to the situation ten years ago when it was necessary virtually to apologize for their use. The designer then was faced with the choice of hydraulic versus mechanical systems. And while aware of the many advantages hydraulics offered—infinitely variable speeds, flexibility of cycles, low upkeep, finger tip control, et al.—he also knew that use of hydraulics might make him the butt of skeptical customers or facetious competitors.

This definite change in thinking on the subject may be ascribed to such developments as means for eliminating air in hydraulic systems; improvement in pump design; perfection of valving technique; methods for determining the operation of complex systems by the use of the electrical analogy.

In roadmaking machinery—even in snowplows—we now find hydraulics. In paper, rubber, linoleum, and floor cloth mills, the calender rolls and other equipment are often driven by infinitely variable hydraulic transmissions. In large transport planes, hydraulic equipment is employed in raising the landing gear and in the operation of the automatic controls.

Not only in America, but abroad, the same situation exists. At the Leipzig Fair, 40 per cent of the manufacturers of machine tools of all classes exhibited machines with hydraulic movements or controls. In the field of precision grinding machines this figure was 95 per cent—in the field of broaching, 100 per cent.

Modern machine tools illustrate the scope of hydraulic applications of all types, from the extremely simple wheel-truing circuit on the centerless grinder to the most complicated circuits such as shown in *Fig.* 6. In fact, hydraulic circuits for machine tools today are comparable to radio circuits. Resistances in series and parallel, together with the many pressure and flow control valves, present networks of equal complexity to radio circuits with their electronic valving, inductances and capacities.

Fig. 1 shows one of the pioneering achievements

Cannot Be Denied! — Part I

in hydraulic machine tools, the hydromatic bed type milling machine. Flexibility of control and ease of operation together with the advantage of a multiplicity of automatic and semiautomatic cycles by the mere setting of dogs have made this machine adaptable to a wide variety of production milling operations.

The piston and cylinder are beneath the table, while the feed rate control lever is located on the hydraulic unit at the left end of the bed as seen in the illustration. Other levers on the bed control such functions as start-stop, feed and traverse rates. The circuit employed is the so-called locked circuit shown in *Fig.* 2, where the rate of table movement is controlled by metering the oil leaving the low pressure end of the cylinder through the variable delivery pump *A*, thus locking the piston between the two pressures. Another novel feature of this circuit is the use of the differential relief valve *B*, which insures that the sum of the forward and back pressures remains constant and permits a complementary rise and fall of both forward and back pressure to suit the work resistance.

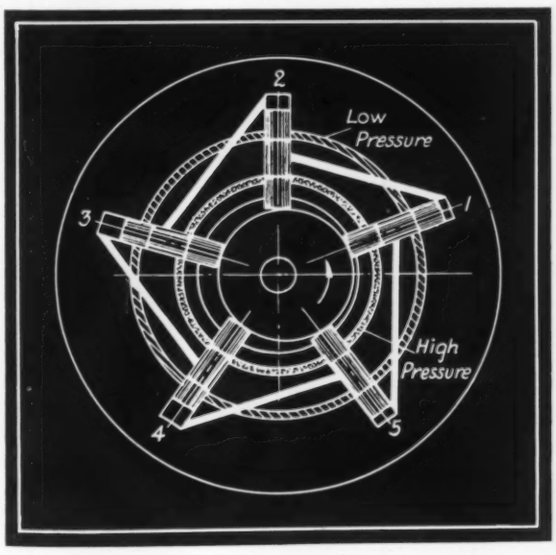


Fig. 3—Booster pump for high pressures and low volume, the five pistons being reciprocated by an eccentric rotating in a counterclockwise direction.
Fig. 4—Right—Milling machine with four sets of cutters for milling locating pads on two crankshafts

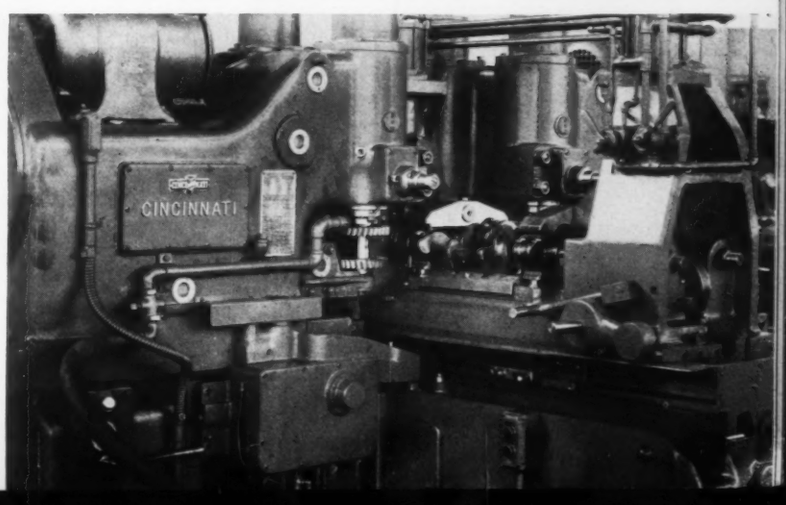
This device allows the average pressure level of the system to be reduced to substantially one-half that of a constant forward pressure system.

Another feature of the circuit is the use of a booster pump. In any closed circuit, compensation for leakage must be provided for by the use of a super-charging pump in the back pressure line or, as in this system, a pump in the forward pressure line. This pump must perform the additional function of boosting the pressure to a point where the differential valve will open. Since the leakage is small the volumetric requirements of the booster pump are also small.

Eccentric Reciprocates Pistons

Fig. 3 shows a unique design of pump for high pressures and low volume in which the five pistons are reciprocated by an eccentric. Counterclockwise rotation of the eccentric is indicated. Therefore, at the instantaneous position shown, pistons 1, 2 and 3 are displacing oil, while cylinders 4 and 5 are being filled by the rapid traverse pump (*Fig.* 2 at *C*). The flow of fluid is valved to the forward or back pressure lines by means of necks in the adjacent piston. Thus each piston is employed as a valve for the pump chamber to its right.

This design is particularly suited for high pressures because it employs a minimum number of moving parts which reduces leakage due to wear. The valving system is also simple and very effective from a leakage standpoint. It should be noted that as the valve porting on piston 2 is crossing over from high pressure to low pressure, piston 1 is pumping a minimum since it is passing over dead center on the eccentric. It is obvious that the tortuous path of the



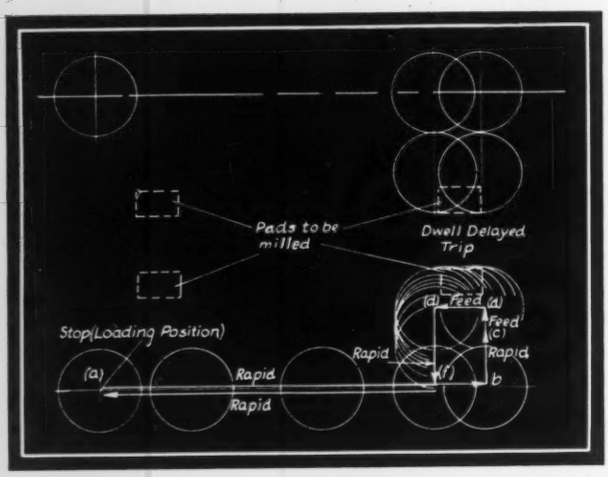


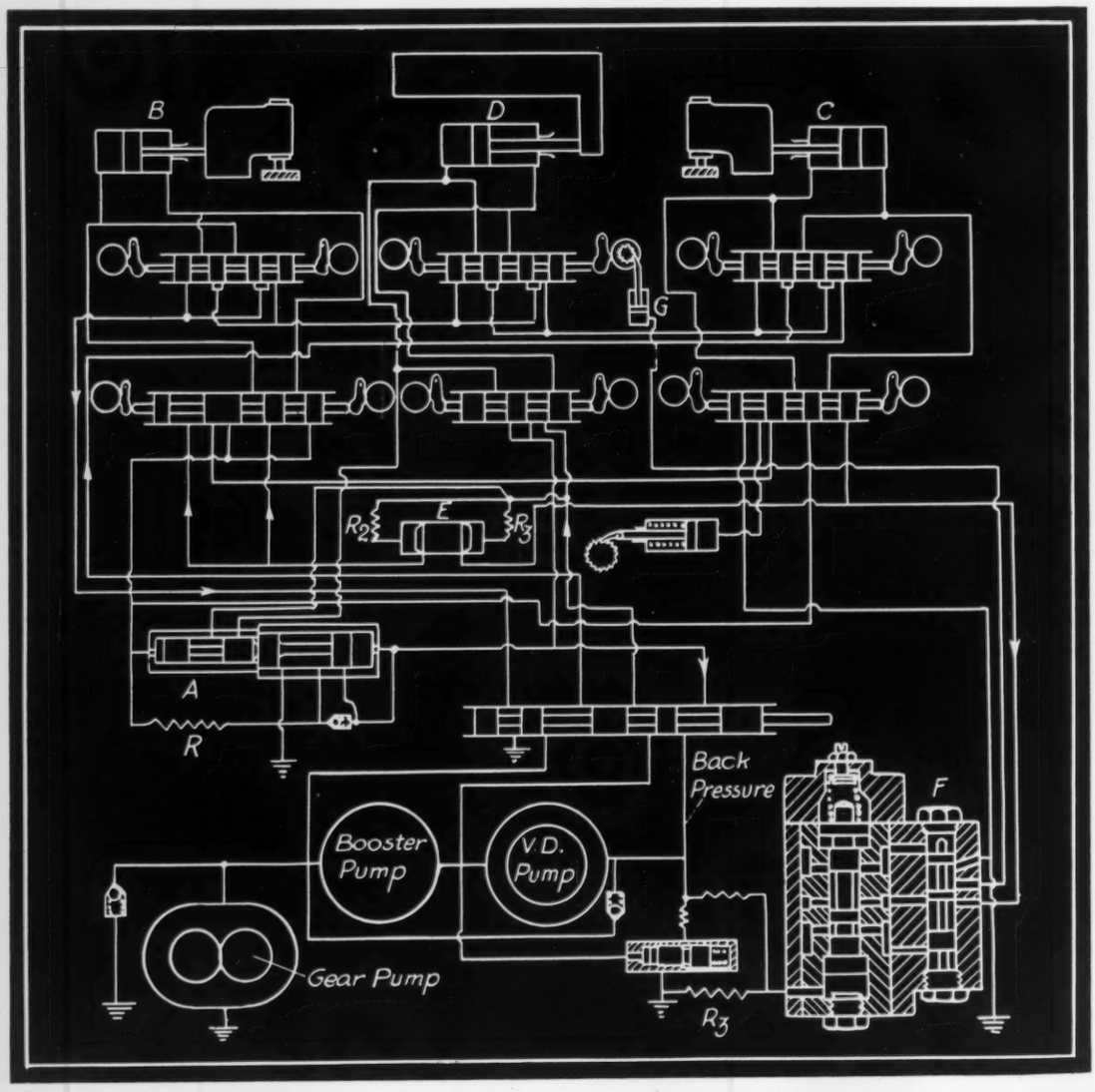
Fig. 5—Complete schematic path, with respect to the work, of one of cutters shown on machine in Fig. 4

Fig. 6—Below—Complicated modification of the locked circuit, complexity being necessitated by the additional functions of cyclic operation of two slides operating at right angles to the table in timed relation to its movement

fluid together with small port openings which are unavoidable in this design would preclude its practical use for high displacement pumps.

Fig. 4 shows a milling machine which has four sets of cutters for milling locating pads on two crankshafts at one time. Schematically, the complete path of one of the four cutters with respect to the work is illustrated in *Fig.* 5. The circuit in *Fig.* 6 is easily identified as a complicated modification of the locked circuit. This added complexity was necessitated by the additional functions of cyclic operation of two slides operating at right angles to the table in timed relation to its movement.

Many novel forms of valving are employed in this circuit. At *A* in *Fig.* 6 is shown the so-called unloading valve which is shifted when the flow through resistance *R* ceases. The return oil from the "in and out" cylinders *B* and *C* flows through resistance *R* which causes the total pressure acting on the left end of the valve to exceed that on the right end in spite of the differences in area. When flow stops, however, the unit pressures on both ends of the valve



become equal, thus shifting the valve to the left. This shift of the valve is used to open and close connections between the forward pressure and the main cylinder *D*, maintaining pressure on the cylinder during the feed of the "in and out" cylinders.

At *E* is shown a balancing valve which insures equality of pressure drop across the two resistances R_2 and R_3. This results in equal flows through the two legs at all times, and fulfills the requirement of equal feed rates on the two "in and out" cylinders.

When these cylinders reach the positive stop at *d*, *Fig.* 5, a short dwell is required to clear the cutters. Delayed trip valve at *F*, *Fig.* 6, is used for this purpose. As soon as the slides strike a positive stop, the back pressure immediately falls to zero. Since this pressure was holding the delayed trip valve in its upper position during the cycle, the valve will begin to

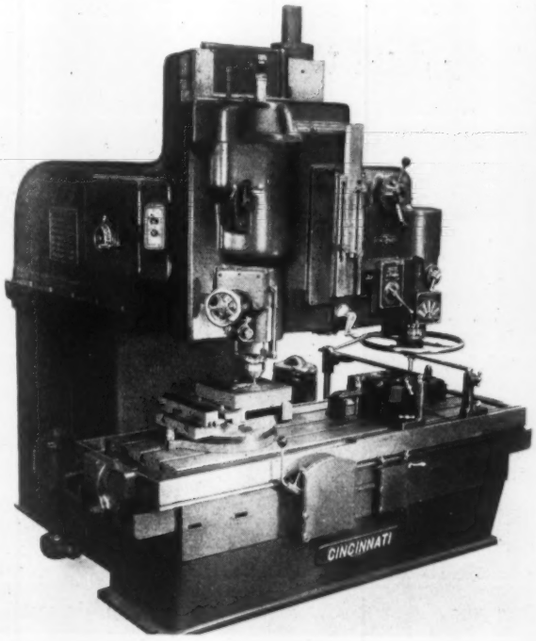


Fig. 7—Sensitive control of ponderous masses such as slides on this hydro-diematic milling machine is one of the more recent applications of hydraulics

drop by reason of a spring urge at the top. The movement of the valve is sluggish, however, because the oil must be displaced through resistance *R*. When the valve has completed its movement the ratchet at *G* is shifted, which causes the cycle to resume.

This circuit is cited as an example of the complexity which may arise when complex results are desired. Sequential and simultaneous functions as well as delays can be obtained by the use of flow and pressure-controlled valves.

At one time, hydraulics was considered an agency of brute force as typified by the tremendous rams of the hydraulic presses, the forces of which are measured in tons. A more recent application is that of sensitive control of ponderous masses such as the slides shown in *Fig.* 7. This machine is the milling machine used principally for duplicate milling of drop forging dies and similar parts. Although the massive design of the slides and frame permits the use of large cutters and heavy cuts on roughing operations, light accurate cuts are easily attained. The use of a sensitive hydraulic control makes this wide range of operations possible.

At the right in the picture is shown a handwheel to which a finger, called a tracer, is attached. This tracer finger is directly connected to control valves

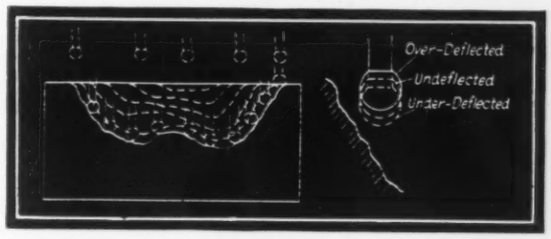
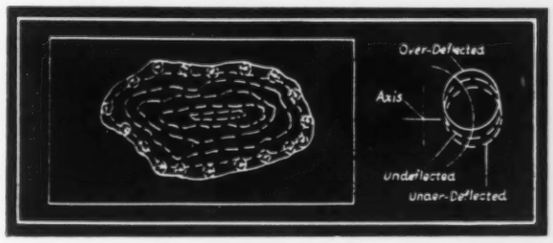


Fig. 8—Control valves in three primary positions are directly connected to a tracer finger on a handwheel. Tracer mechanism always seeks equilibrium.

Fig. 9—Below—Horizontal plane method of tracing, showing three primary positions of the tracer as angular positions about an eccentric axis



which have three primary positions as determined by three positions of the tracer: "Undeflected," "over deflected," and "under deflected," as shown in *Fig.* 8. The normal noncontacting position of the tracer is the "under deflected" position which will cause the tracer to move toward the master die. As the tracer is deflected, the other component of feed is thrown in, tending to cause the tracer to move away from the master die.

In the "undeflected" position the feed components are equal, thus providing a feed angle of 45 degrees. In the "over deflected" position the tracer tends to leave the master. Thus, the tracer mechanism is always seeking equilibrium which it finds only when the slope of the contour is constant. A horizontal plane method of tracing is shown in *Fig.* 9, indicating three primary positions of the tracer as angular positions about an eccentric axis. In both methods the movement from one primary position to the next represents very small displacement (approx. .001). The dotted contours in both *Fig.* 8 and *Fig.* 9 are contours at various parallel planes. The horizontal plane method of tracing employs the table slide for the right and left component of movement while the "in

(*Concluded on Page* 62-S)

Fig. 1—Instrument locates and measures vibration

To Help Machine Sell— Use Quiet Drive

By John W. Greve

QUIET operation of machine drives is important not only because of its economical aspects but also with respect to psychological and physiological effects on personnel. Designers appreciate the premium placed on noise and have done much toward making their designs quiet in operation.

With increasing mechanization in plant, office and home the resulting volume and intensity of noise would become a definite liability if advances in design did not mitigate this troublesome factor. Although affecting people in different ways, noise has been shown to retard mental alertness, to harm digestion and to impair hearing. Noise above 50 decibels is generally annoying and productive of irritability. Reduction in sound level from 50 to 40 decibels, which actually results in halving the loudness, increases mental alertness by more than 30 per cent. Observations by Smith and Laird show that levels above 60 decibels inhibit the normal activity of the stomach. Noises between 80 and 90 decibels cause a decrease of 37 per cent in the rate of stomach contractions.

Wherever practical, noise is best obviated at its probable source. When it already is present, redesign or improvements in manufacturing methods may eliminate factors at fault. Parts quiet in themselves may vibrate in resonance and cause annoyance. For example in a noisy machine it was found that the drive and machine were each quiet when driven separately but when coupled together the resonant vibrations were disturbing. A slight redesign eliminated the trouble. *Fig.* 1 illustrates a method for locating source of noise and its intensity.

Noise either is air-borne or transmitted through a structure to a resonant part. This latter type causes the gravest concern. If the disturbance cannot be entirely eliminated, isolation through the use of insulating mediums often can further reduce objectionable vibrations. Enclosing insulated housings where they may be used are effective in reducing air-borne disturbances.

Everyone is not in accord as to the degree of quietness attainable for various forms of drives. Application and location dictate the extent to which

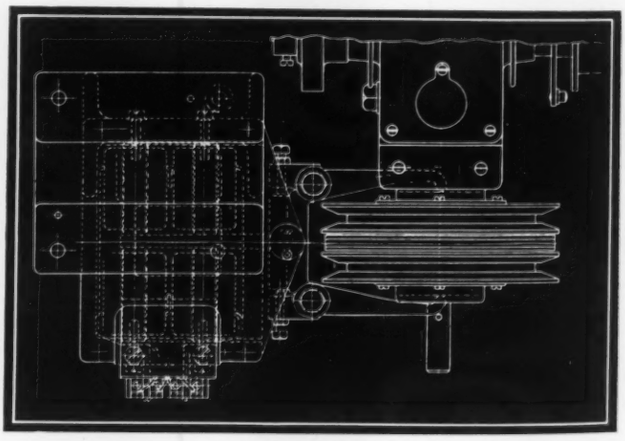


Fig. 2—Magnetic clutch designed for speed change on office machine where quietness is important

it is desirable or economical to go in this direction. Since the cost of decreasing noise beyond a certain point is not justifiable, many designers take ambient noise levels and design their equipment to come below these values. This trend seems practical. For example in a water condensing system, blowers are designed to have a decibel reading below that of the falling water in the tower. The drives in turn are selected to have a value well below that of the fans. Thus no noticeable noise factors are attributable to the drives involved.

Noise measurements averaged from many locations show ambient sound levels usually are within the following ranges of decibel readings: Residences, 30 to 55; offices, 40 to 75; factories 60 to 90. Quiet offices usually are under 42 whereas typists' offices give a reading of 75. An extremely noisy factory such as a boiler fabricating plant may be in the vicinity of 100. Therefore, the type of equipment and its ultimate application determine the acceptable noise levels. A quiet drive for one location may be noisy when placed in another.

Electromagnets Quiet Clutch

Discussion of component parts of drives will show the attention being given to the subject and the effective methods employed toward the solution of this important problem. A quiet clutch application for speed change was required in the drive for an accounting machine. The design, *Fig.* 2, employs a magnetic actuating mechanism to provide automatic operation and reduce noise to a minimum. Operating with a speed of 25 milli-seconds, the clutch effects engagement of high or low speed pulleys through energization of either of their respective magnets. This causes the attracted armature to force the pulley into engagement with the facings of the clutch disk. Because the armature does not strike the magnet cores or a fixed stop of any kind quietness is obtained. Clutch facings act as a cushion and absorb the noise.

Belts and chains must be applied carefully when the ultimate in quiet operation is desired. Belt drives are inherently quiet and when properly applied tend to absorb noise rather than transmit it. However, in some applications belts are a source of noise in themselves and require particular attention. In domestic refrigerators special steps have been taken for reducing noise of the V-belt drive such as producing belts without surface rubber, polishing and plating the pulleys, etc. In industrial applications slippage may occur, particularly on starting, resulting in loud squeal. This is due to lack of capacity or of sufficient driving tension. Proper selection of drive will avoid such cases. Other instances of noise may develop from the accumulation of rust on the belt caused by oxidation of the pulley. Choice of suitable pulleys and location may obviate this cause of complaint.

In the use of high speed chains for positive drives, short pitch chains properly enclosed and lubricated usually give quiet performance. Chains operating at unusually high linear speeds may carry higher loads by increasing the size of the sprocket while at the same time providing smoother and quieter operation with longer life.

Manufacturers of industrial gears have given a great deal of thought to the problem of eliminating vibration and noise. Considerable progress has been made in this direction which may be illustrated by reviewing a few developments.

Fig. 3—Inspection of tooth form and spacing of small gear. All movement is positive against fixed sine bar. Dial graduations are .0001-inch

To avoid noise due to bad approach angle a gear manufacturer has deliberately cut away the top of the teeth on the driven sides so that contact is taken near the operating pitch line.

Spur gears are the noisiest form because of their short contact periods between teeth. The tips of the teeth on coming in contact interrupt the motion rather than continue it. Elimination of this difficulty is indicated in good design by increasing the number of teeth and decreasing the pitch. Steps also should be taken to obviate distortion caused by hardening which frequently gives cause for noise. Cyanided gears tend to increase size while carburizing shrinks. Allowances for these changes should be made.

Tooth to tooth gear spacing often is limited to .0003-inch. The deviation of the tooth profile from a true involute curve is limited to .0003-inch. Error in lead is limited to .0005-inch. A method for inspecting tooth form and spacing is shown in *Fig.*

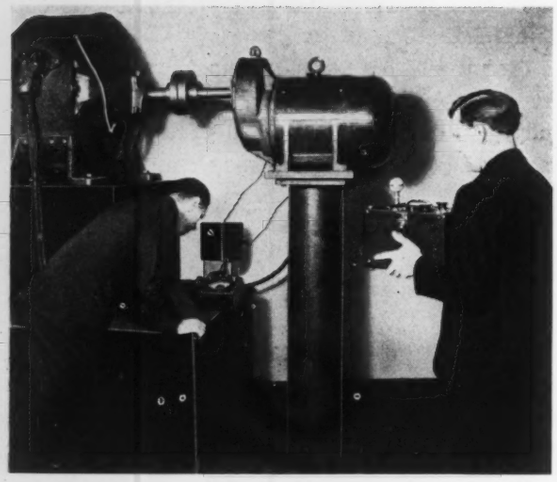


Fig. 4—Noise level test on gearmotor simulating field operating conditions. A reading of 70 decibels is permissible for this unit

3 which employes positive movement against a sine bar.

In the design of most gearmotors the high-speed pinion is mounted directly on the motor shaft. To obtain the best results the boring of the pinion and the machining of the motor shaft are held to close limits. Pinions are heated in oil and shrunk in place to eliminate possible inaccuracies of pressing on cold.

Results obtained from holding individual machining operations to close limits are checked by testing completely assembled units, as illustrated in *Fig.* 4. This application requires mounting a gearmotor on a tubular pedestal and tests are made at the factory wherein the vibration of the pedestal is measured, together with a decibel reading of noise. All units for this application are held to a maximum noise level of 70 decibels.

Resilient Mountings Reduce Vibrations

Often application of nonmetallic gears such as laminated phenolics solve an otherwise troublesome problem. Mating with metallic gears the resilience and inert character of the gears tend to absorb vibration and deaden the noise which might be set up by the mating teeth. Softer than metal, laminated plastics have a modulus of elasticity about 1/30 that of steel and will compensate in a measure the effect of errors in dimension of spacing or tooth form. Since some errors are always present due to machining inaccuracies this ability to distort and compensate for irregularities without setting up appreciable stresses is an important factor.

It is difficult to build electric motors which are free from vibration. Rapid changes of magnetism cause the magnetic iron to vibrate within the audible range, that is between 20 and 15,000 vibrations per second. However, most motor noise is due to improper manufacture which might include uneven air gap, rotor out of balance or loose bearings.

Because vibration is inherently present, various methods may be used to insulate the motor with rubber mountings. Most manufacturers have standardized on rubber rings around the hub of the motor for fractional horsepower ratings, springs no longer being as popular as they were a few years ago. Larger motors are insulated at the bedplate. A good elastic mounting properly applied reduces the transmitted amplitude to as little as 1/50 of the original. If not properly applied, however, insulation will in many cases actually increase the transmitted noise.

In insulating a bedplate it is desirable to mount the driven members on the same plate and insulate the entire mechanism as illustrated in *Fig.* 5. All

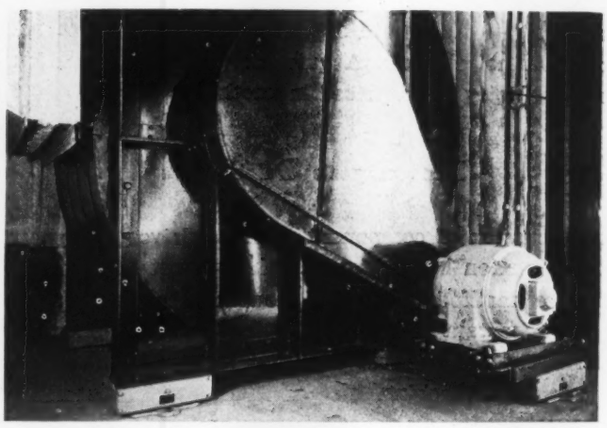


Fig. 5—Insulated base reduces transmission of noise from fan drive. Note fan and motor are mounted on same insulated base. Canvas section in blower duct assists in isolating vibrations

external parts should be flexibly connected to provide freedom of motion and reduce transmitted vibrations. The choice of resilient mounting should be such that the load does not stress it beyond resilient limit. The vibrational period of the insulation should be well below that of the machine, the softer materials usually being advisable. Also ample provision should be allowed for torsional stress so as not to overload the vibration absorbing medium.

Thus the designer may employ numerous methods for quiet operation. Further, by using ingenuity he may be able to anticipate advances in his field and thus prevent early obsolescence which might be caused by a general reduction in noise levels.

MACHINE DESIGN is glad to acknowledge the co-operation of the following companies: Internal Business Machines Corp.; Dayton Rubber Mfg. Co.; Morse Chain Co.; Armstrong Cork Co.; Goodyear Tire & Rubber Co.; United States Rubber Co.; Formica Insulation Co.; General Radio Co.; National Broach & Machine Co.; General Electric Co.; Westinghouse Electric & Mfg. Co.; Marathon Electric Mfg. Corp.; Sterling Electric Motors, Inc.

Looking Ahead!

"... applied during development."

R. S. ELBERTY, Electrical Engineer
Landis Tool Co.

HIGH production machines are passing from the "semiautomatic" to the "full-automatic" stage of development. This places emphasis on loading and unloading devices that function automatically and are controlled by automatic sizing means. Electrical control of full automatic machines depends to a large extent on accessory equipment such as timers, sensitive switches, pressure switches and pushbuttons. These accessories and special groupings of standard control units will go together to make up the highly specialized control of automatic machines of the future.

The specialization of machine tool control can be advanced by custom-built electrical accessories. For example, a position stopping switch for a relatively high speed motion must operate 50,000 times a day or 15,000,000 times a year. No ordinary limit switch can stand such heavy duty, and additional mechanisms have been devised to move a standard switch into contact with a stopping cam when necessary. A specially designed switch using a long, hardened plunger operating in a cast-iron bearing has worked out satisfactorily on such applications, eliminates the special mechanism, and shows a longer life than standard switches used on light duty applications.

Hydraulic drives have a definite, established field on machine tools which will probably be enlarged through the increasing use of electrical control for hydraulic motions.

Future machines will be designed to present a neat and compact appearance. No single rule of design will accomplish these results better than that of including the motor and control equipment within the lines of the machine. Electrical equipment can be built into machines in such a manner as to reduce costs, and the designer must bear in mind that special motors and elaborate control equipment ordinarily are expensive items. Above all, electrical drives should be applied to the machine as the design progresses and not as an afterthought.

"... constantly finding new possibilities."

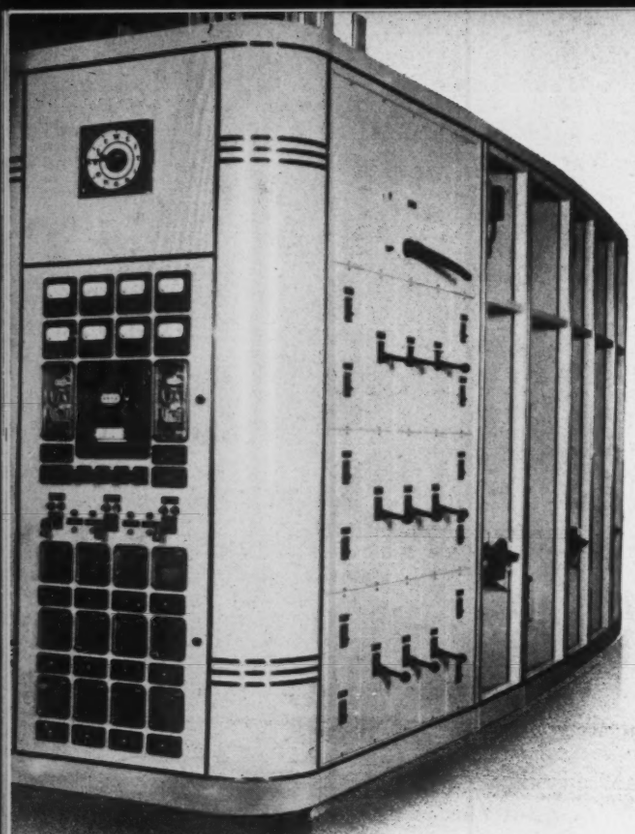
B. P. GRAVES, Director of Design
Brown & Sharpe Mfg. Co.

A NEW trend is being developed in driving machinery, through utilizing the natural functions found in electric motors and their controls. This has brought about many changes in the application of motors and controls to machine tools, and designers are constantly finding new possibilities which tend toward machines having more efficiency, more versatility, and much more pleasing appearance.

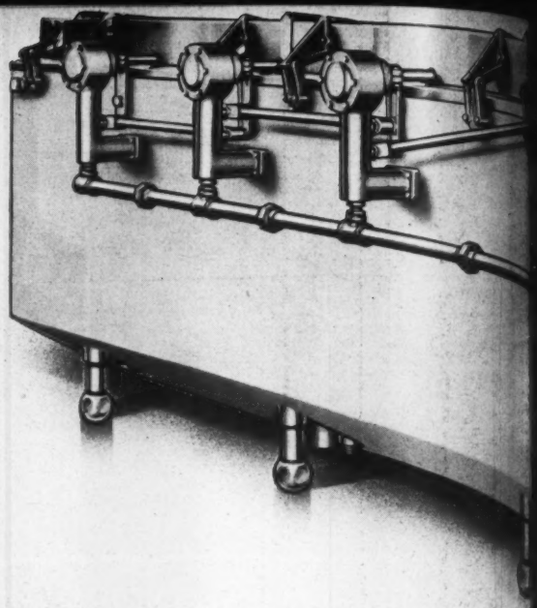
It is not surprising that the functions available in electric motors and controls, such as reversing, stopping and starting, plugging to rest, speed changing,

(*Continued on Page* 64)

TRENDS in design are brought about when theories are applied, insofar as practicable, to actual machines. Conversely, one of the best ways to discern broad tendencies in design is to inquire into current and presaged practices. In this series of brief discussions by men intimately connected with design of progressive equipment, several indications are apparent regarding new applications of drives and controls. These comments, it is hoped, will provide other designers with food for thought in dealing with present-day problems of power transmission and control

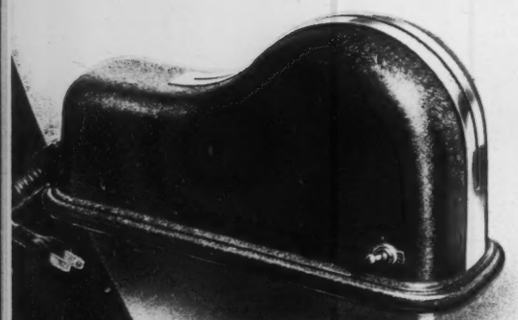


Rear view of Fort Wayne Pad-L-Vat milk pasteurizer (right) shows variable speed drive for agitators. The paddle cools or heats milk by circulation of the medium through the hollow shaft into the paddle proper. All covers are of aluminum or stainless steel; outer tank, or water jacket, is Armco iron

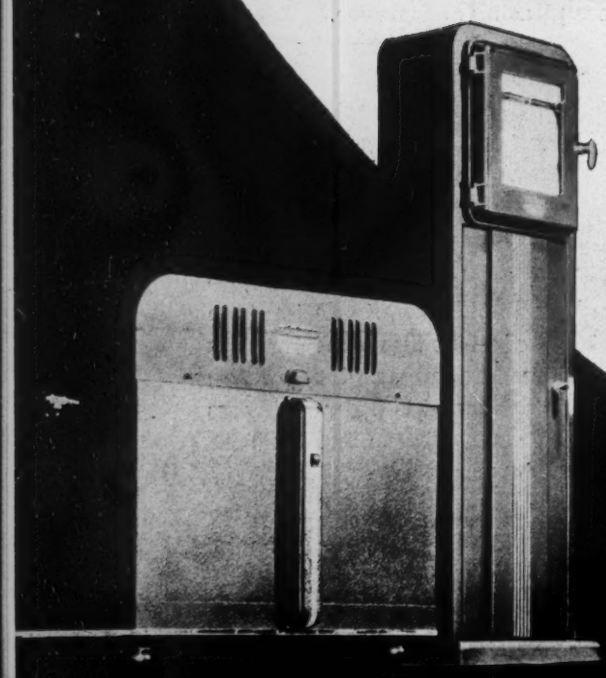


Slightly curved contour of the Westinghouse switchboard (left) conforms to the shape of the company's exhibit building at the New York World's Fair, and controls the power for the structure. De-ion circuit breakers are provided for the incoming 2300-volt lines and a similar unit sectionalizes the bus. Switchboard panel carries all instruments, meters, relays and control switches

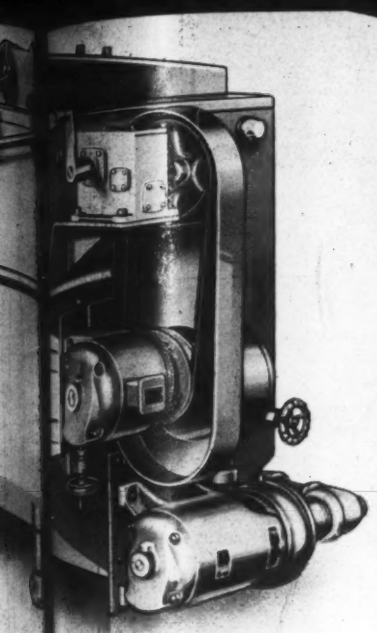
Design
In New
With Particular Re
tion of Drives



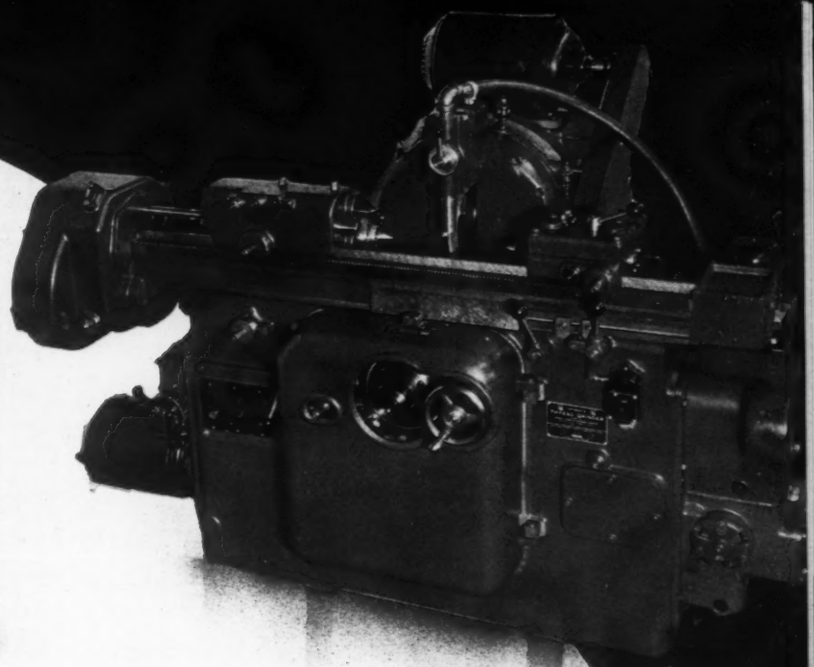
Universal motor and gear unit of the Duwell knife grinder (left) furnishes a drive of 15,000 revolutions per minute for the abrasive blades ratio. Four segmental blades of special shape give true abrasive action against the knife. The housing, mounted on a heavy steel base, is an aluminum alloy casting with polished trim and body in baked lacquer



Motor of the Cutler-Hammer calorimeter (left) is direct-connected with gear trains rigidly aligned on a supporting trunnion. Longer service comes from use of brass for underwater parts. Oilless bearings are used for all slow-moving shafts. The protecting glass cover, recorder chart and recording mechanism swing out on hinges for greater accessibility and embody a synchronous motor chart drive



The Jones & Lamson universal automatic thread grinding machine (right) is designed around the automatic wheel-truing device, guaranteeing close tolerances. A cradle on which the grinding wheel spindle and its driving motor are mounted permits tilting the wheel to correspond with the helix angle of the thread to be ground. The work drive is from a motor geared to a transmission shaft which also furnishes power for table travel. Individual motors operate a coolant pump and wheel-truing device



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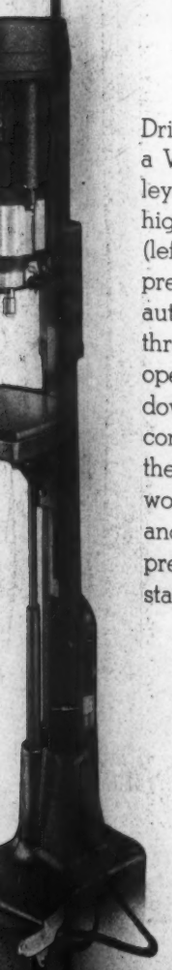
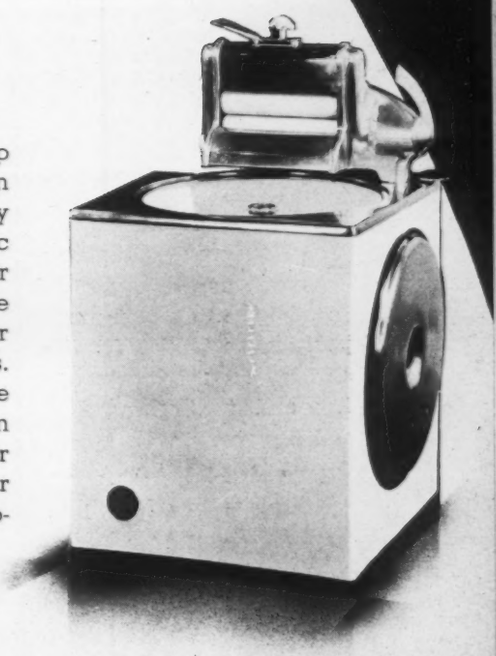
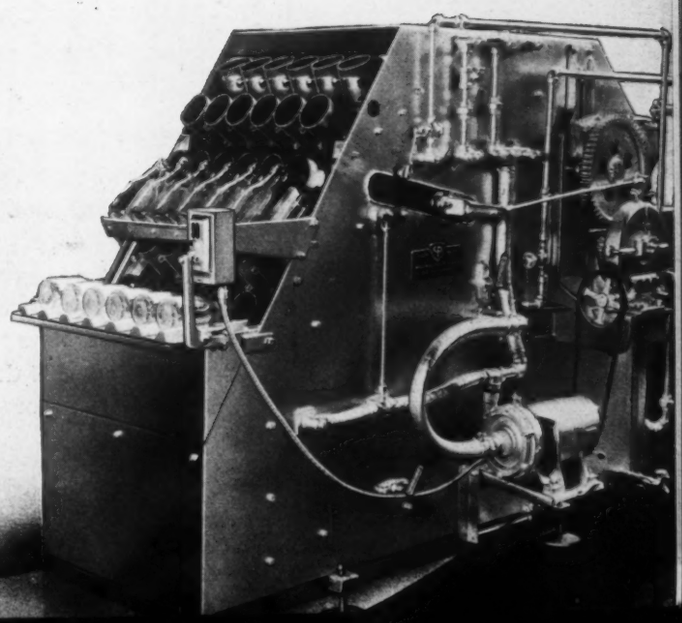


Driving the tap head through a V-belt and multispeed pulleys, the motor in the Haskins high speed precision tapper (left) is stationary. Compressed air, admitted to an automatic air control valve through a pressure regulator, operates the tap head up and down. The automatic valve controls the speed with which the tap is presented to the work, the tapping pressure, and the reverse speed and pressure. A foot pedal unit starts or stops the tapping



Washer, wringer, drain pump and ironer of the Thor kitchen laundry (right) are operated by the same motor, with automatic fingertip control. The agitator has three lower fins and six side fins which force the water currents through the clothes. Cover, wringer and ironer are aluminum. The white porcelain enamel tub is triple coated. Air space between tub and outer cabinet pockets the heat, keeping water hot longer



Power for the pump and belt-driven worm reduction drive in the Creamery Package bottle washer (right) is provided by a ¾-horsepower motor. A start-stop switch in conjunction with the infeed safety is conveniently placed and has a thermal overload for motor protection. Drive chain is advanced by pawl and ratchet wheel keyed to the shaft carrying sprockets on each side of the machine. The sprockets are located at the rear at a point where chain pull is normally the hardest. Welded construction of the tank is reinforced by welded catch-pans and bolted chain rails

Fig. 1—Electronic inspection machine automatically sizes piece and tests hardness

Electronics Make Difficult Processes Simple

INHERENT sensitivity and accuracy of operation of electronic controls make possible many automatic machine methods hitherto impracticable. In addition to serving as limit switches in many capacities, some not feasible with mechanical means, electronic devices control temperature, color, matching and time intervals. Where mechanical limit switches cannot be applied successfully, such as in conditions involving unusually severe service or insufficient energy to trip a switch, phototubes are particularly applicable. They also serve to initiate sequences of operations whether from a printed pattern, color or temperature of a processed part. Electronic controls for welders apply definite current values for specific time intervals accurate to 1/120-second.

Unusual applications of phototubes in an ingenious automatic inspection machine are shown in *Fig.* 1. The machine measures small permanent mold castings for roundness, length, diameter, wall thickness, and also tests for hardness. All these processes are performed electronically.

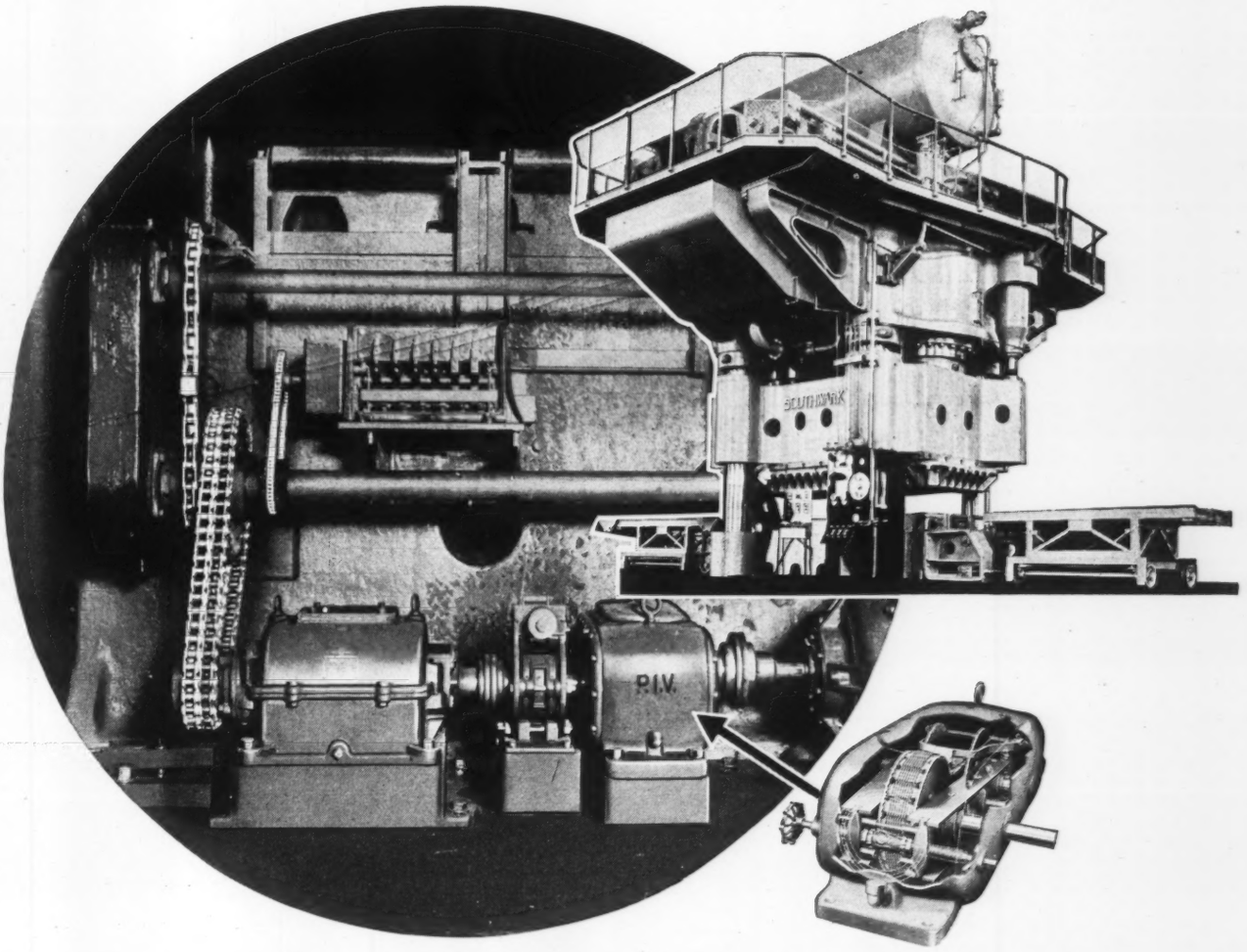
Gage heads on the machine for measuring dimensions are full-floating so that slightly misplaced or misaligned parts do not affect the accuracy of measurement. The gage head, as it comes down over the piece being tested, floats into position. After the position has been acknowledged by the various circuits, the direct current anode or plate supply flows through a series of relays to a tube. In so doing, if the piece is out of dimension, the gaseous triode or trigger fires.

This fired condition energizes a relay coil and the contacts select and hold the impulse for the rejection solenoid, which pushes the piece out of the complete line of measuring stations. In other words, the gaseous tube acts as a medium to store the impulse after measurement has been taken and to acknowledge through the balance of the circuits whether the piece should be rejected or passed.

For measuring hardness a photoelectric scleroscope, as seen in the foreground of the machine, is employed. The unit is arranged so that cams on the timing device for the entire machine open up the plate circuit of the photoelectric amplifying tubes during the falling stroke of the hammer. As soon as the hammer bounces on the piece, the plate circuit above is closed by the same cam and limit switch. If the piece is sufficiently hard, the scleroscope hammer bounces into a ribbon of light and the piece is passed.

Electronic Tube Controls Temperature

Temperature control with phototubes is illustrated in *Fig.* 2. Designed for resistance heating of 1-inch bars, on both ends, this automatic heater is operated by an electronic tube. Bars are fed from the hopper to the jaws. Hydraulically closed, the jaws pass current at each end heating the bar by its resistance until it reaches a predetermined temperature at which by radiation the calibrated tube operates. Jaws then open and the piece is ejected on the chain conveyor thus admitting another piece to the jaws to complete



P.I.V. GEAR REGULATES FEED OF MAMMOTH HYDRAULIC PRESS · INSTANTLY · POSITIVELY

● Here is a striking example of the wide adaptability of the P.I.V. Gear variable speed transmission. Aside from its tremendous size, this huge 5500-ton capacity hydraulic press is noteworthy in two other particulars: (1) A hydraulically operated head, movable up or down, for applying pressure to the duralumin sheet mounted over male die on subplaten is employed; (2) Work is placed in position for stamping and removed when finished, by special Link-Belt conveying equipment, driven through Link-Belt positive drives—P.I.V. Gear, herringbone reducer and Silverlink roller chain.

Work is placed on press subplatens, carried to the press by special trucks. The platen is manually pushed off the truck until a dog on the special drive chain engages it and moves it onto the press bed, automatically stopping when the work is accurately centered. The finished stamping is then moved to a second truck, at the same time a new sub-platen is being brought into position.

Size of piece being stamped governs speed requirements, and speed variation is instantly had by means of the P.I.V. Gear unit direct connected to the motor. Electric remote control enables the operator at his position, to regulate the speed of moving sub-platens into position on the press.

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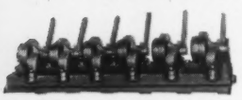
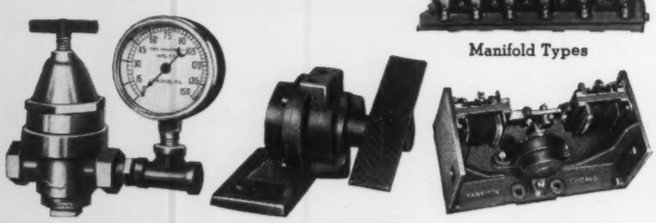


Manifold Types



Pressure Regulating Valve

Pedal Operated Valves

Electric Types

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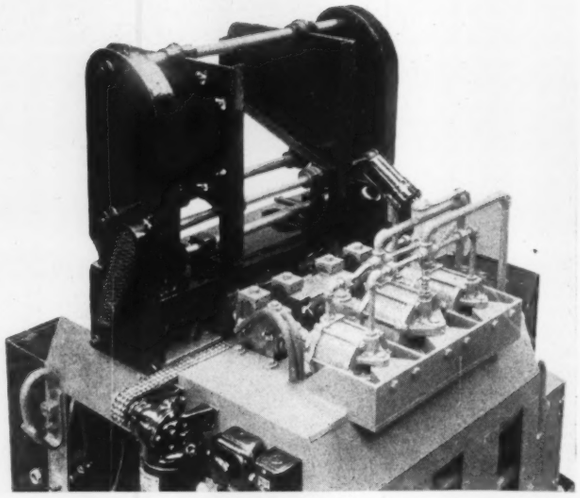


Fig. 2—Phototube controls resistance heater to produce a uniform product every eight seconds

the cycle. Every eight seconds a bar is heated to the correct temperature to produce a uniform product. Should the tube fail, never more than one piece would be spoiled. The machine oscillates without heating.

Safety control of machines for protecting operators from harm have proved successful where mechanical methods too often retarded production. In such uses it is important to apply negative control for protection against failure of any part of the system. Then the machine is merely inoperable until the fault is corrected. *Fig.* 3 shows such a safety application on an embossing press. A light beam 12 inches in height covers, for all practical purposes, the press opening.

Any open leads, power failure, broken relays, burned out amplifying tubes or loss of emission of the photoelectric tube would cause the primary relay to become de-energized, thereby dropping out and stopping the press. The press is also equipped with an electronic timer.

Vacuum-tube timers have wide application in indus-

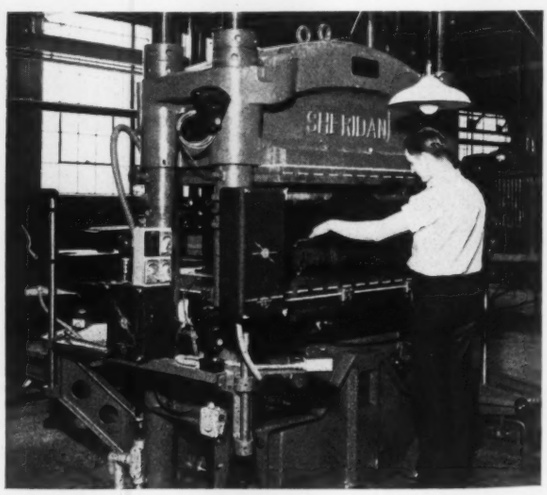
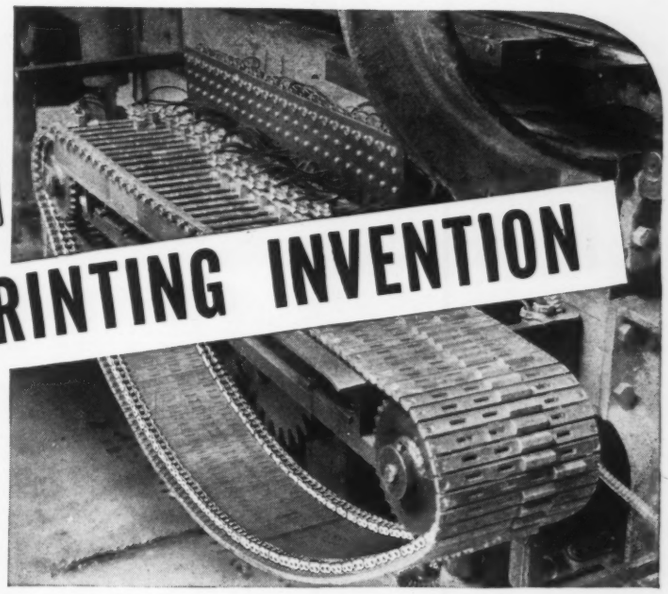


Fig. 3—Safety is assured by phototube light fence

What Design Engineers are doing with Silverlink Roller Chain!



NEW RUG PRINTING INVENTION

an interesting application
of Silverlink Roller Chain

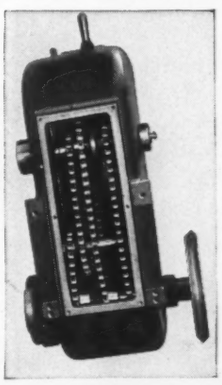
To make rug printing a continuous operation, Dienelt and Eisenhardt, Inc., Philadelphia, developed and patented an Electric Master Control in which they use two matched strands of Silverlink roller conveying chain. A good example of how ingenuity and Silverlink make effective teammates.

THE exceptional performance that is inherent to Silverlink Roller Chain has made it the favorite of leading design engineers and production men, for drives and conveyors. Its smooth, positive action—its rugged durability—its flexibility and good appearance make it the practical chain for countless applications.

Send for Data Book No. 1757—It contains 174 pages of meaty, illuminating information — list prices, ratings and bed-rock figuring and design data.

Link-Belt Company, Indianapolis, Chicago, Philadelphia, Atlanta, San Francisco, Toronto. Offices and distributors located in principal cities. 7648

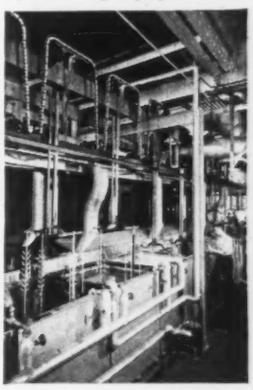
Costs Reduced with Silverlink Roller Chain



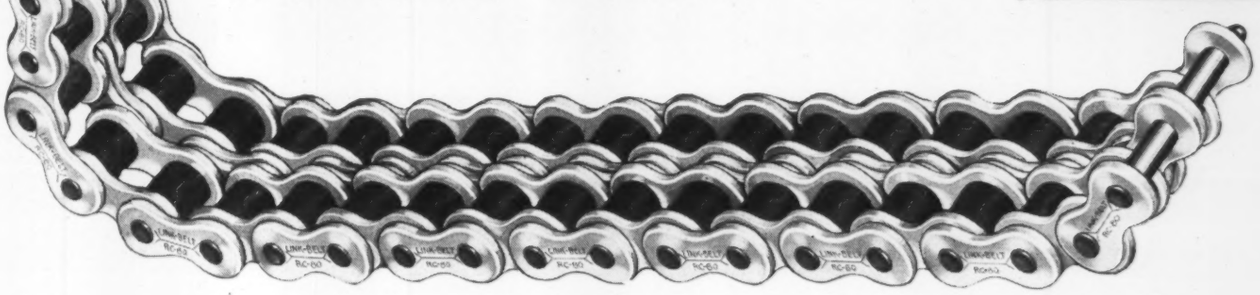
Because they developed their honing and reamingmachine with Silverlink Roller Chain as the internal transmission instead of a series of gears, the Automotive Maintenance Machinery Co., North Chicago, Illinois, were able to cut costs and keep their selling price advantageously low.

Automatic Metal Plating!

The Meaker Company, Chicago, design and build automatic plating and processing equipment for a wide variety of industries. They are constantly developing new applications of roller chain to meet unusual conditions of service and production. The installation illustrated is in a plumbing fixture plant and shows their Return-type, Full Automatic Metal Plating Unit in which Silverlink Roller Chain is used.



LINK-BELT
Silverlink
ROLLER CHAIN



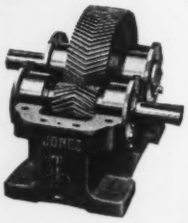
SINGLE!
DOUBLE!
TRIPLE!

—every type of
Herringbone Speed Reducer
that you might need

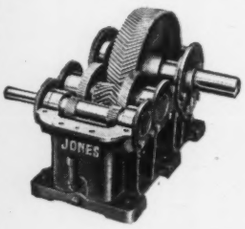
JONES Herringbone Gear Speed Reducers are built in a wide range of ratios and ratings to cover every requirement. Single (Type SH) reducers in standard ratios range from 1.25 to 1 up to 11 to 1 in ratings from 1.3 to 440 H.P. Double (Type DH) reducers are built in standard ratios from 10.9 to 1 up to 72 to 1 in ratings from 0.5 to 275 H.P. The triple reduction reducers (Type TH) cover a range of ratios from 86.9 to 1 up to 355.8 to 1 in ratings from 0.3 to 78 H.P.

All these reducers have heat treated gears, ground shafts and are mounted with anti-friction bearings throughout. Cast iron bases are available for all variations of motor assembly. Liberal stocks are carried to facilitate shipments.

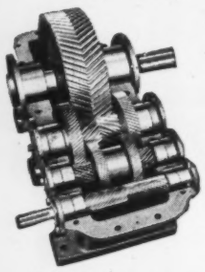
W. A. JONES FOUNDRY & MACHINE CO.
4413 Roosevelt Rd., Chicago, Ill.

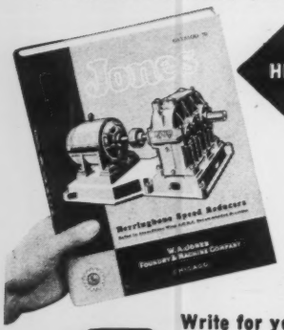


Single Reduction
Type SH



Double Reduction
Type DH


Triple Reduction
Type TH



HERE'S THE LATEST INFORMATION
about the application of
Herringbone Reducers

This new 128-page catalog of Jones Herringbone Reducers presents a vast amount of data relating to Herringbone Reduction Units. Illustrations show a broad range of herringbone reducer applications and the technical information shows how to select reducers for all conditions of service in accordance with the A.G.M.A. recommended practice.

Write for your free copy of this valuable treatise

Since 1890
Jones

HERRINGBONE -- WORM — SPUR — GEAR SPEED REDUCERS
CUT AND MOLDED TOOTH GEARS — V-BELT SHEAVES
ANTI-FRICTION PILLOW BLOCKS — PULLEYS
FRICTION CLUTCHES AND TRANSMISSION APPLIANCES

trial machinery, particularly machine tools which require a definite time delay during operation. The electronic portion consists of a three-element, high-vacuum metal tube. Such timers are reliable in operation and have eliminated some of the troubles experienced with other types of timers.

An application where production has been increased from between 80 and 100 units to 130 per minute by automatic positioning of toothpaste containers, is illustrated in *Fig.* 4. Empty containers to be filled are removed from boxes by a mechanism and placed into the machine. Containers are indexed from left to

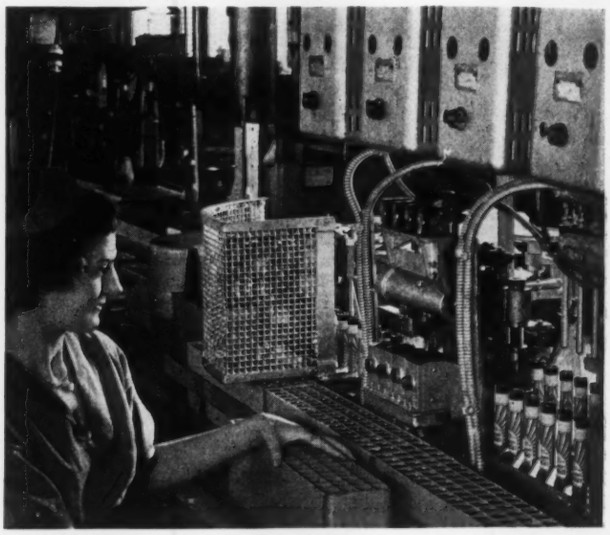


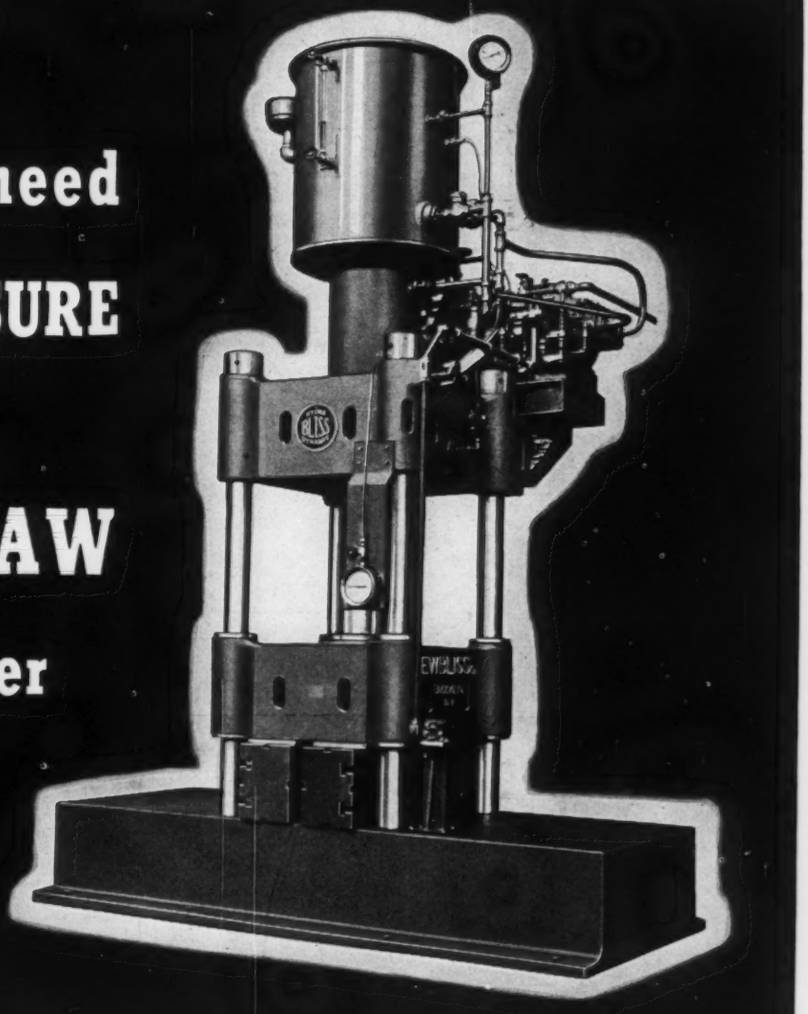
Fig. 4—Filling machine's capacity is increased more than 30 per cent by utilizing electronic register

right four at a time and thus come to the indexing station. Four shielded units house photoelectric tubes and light sources. The differential of reflected light between a black border and a yellow strip on each container affects the phototubes, thereby attaining proper printing registration.

Four expanding mandrels sheathed in rubber lower into the containers and rotate until the yellow band comes before the phototube. At this instant an impulse passes through thyratron relays and thence to four solenoids on the spindle head. The solenoids, each acting independently, disengage the respective clutches on each of the four spindles and cause the tubes to cease revolving at the proper time. From this indexing station the tubes are transferred to the back row on the machine and pass through successive stages of filling, closing, crimping and ejection.

On paper making, printing and wrapping machines electric eyes perform numerous tasks such as control of loop between machines, break indication, edge control, printing register, paper guiding and slitting. The guiding of a web edge of a paper roll on a two-color offset press produces excellent results on a recently designed press. Employing the principle of reflected

When you need PRESS PRESSURE Use HELE-SHAW Fluid Power



THE ability to produce and to control high pressures at the touch of a hand, and to remotely locate the pump, are only a few of the many reasons why machine designers, builders and buyers use Hele-Shaw Fluid Power Pumps. In the American Steel Casting Company plant, for example, steel castings are straightened with a Bliss 150 Ton Hydro Dynamic Press. Operation, without the use of valves, is extremely simple. A Hele-Shaw pump, generating a pressure of 2700 pounds per square inch, is remotely operated by a Hele-Shaw, Type G control equipped with hand operating mechanism. . . . Ask us to show you how Hele-Shaw Fluid Power can be applied to advantage in machines you design, build or buy. It's worth a letter.

OTHER A-E-CO PRODUCTS: Lo-Hed Hoists, Taylor Stokers, Marine Deck Auxiliaries.

A-E-CO Hele-Shaw FLUID POWER

AMERICAN ENGINEERING COMPANY

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This man has FACTS worth money to you

● You'll say, "There IS something new under the sun" when a Lewellen representative tells you about the new *Lewellen Variable Speed Motor Pulley.* It is definitely a new milestone in the history of speed control equipment—a triumph in engineering. More than 40 years experience in speed control engineering is built into this new Pulley. You naturally expect it to have exclusive, important features. It has. Why not call a Lewellen representative NOW and get the facts? A complete descriptive catalog, just off the press, is yours for the asking.

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Lewellen Knows Speed Control

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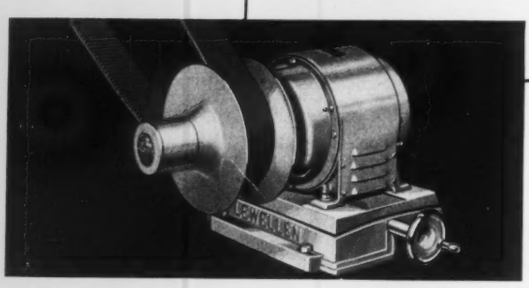
LEWELLEN
Variable Speed
MOTOR PULLEYS



light in contrast between the flowing web and black roller over which it passes for scanning, a phototube and motor method of mechanical correction is used.

Wrapping machines employ various methods of phototube control. On one rotary machine, spot-marks on the labels contact the ray of a phototube unit starting a small auxiliary motor. The motor stops so that each insert is placed in an exact position on the printed label. If the insert should be improperly placed due to the varied speeds of the insert and wrapper, the phototube corrects its placement.

Packaging of paper rolls, which may be performed on a similar machine, requires twisting of the end wrap. A rotating head turns the roll as it moves forward, thereby producing a twist between each roll. This twist passes above a phototube which, contacting the smallest portion of the twist, actuates air cylinders to project cutting knives through the exact center of the twist.

Irregular shaped objects varying in size, such as bread, use similar control with a spotted label for registered design packaging. In a machine using cellophane or waxed paper in rolls printed with register spots, a photocell insures each package having a label in correct position. When the spot, printed at regular intervals, intercepts the beam of light transmitted through the paper to the photocell or reflected from the paper to the photocell, the current through the tube will decrease. By this interruption the paper feeding mechanism is brought to a standstill and a knife automatically cuts the sheet which is spaced properly over the object for wrapping.

Electronic control of resistance welders facilitates the accurate welding of aluminum alloys, brass and other metals difficult to join. A 700 KVA machine

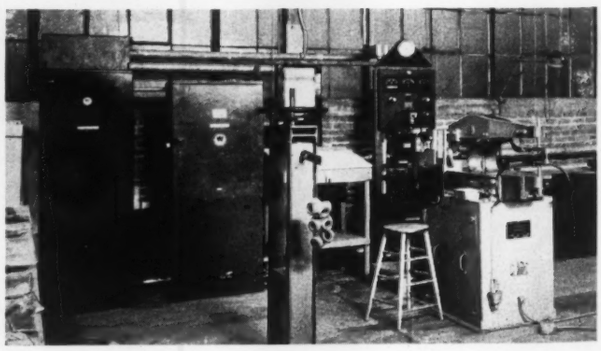
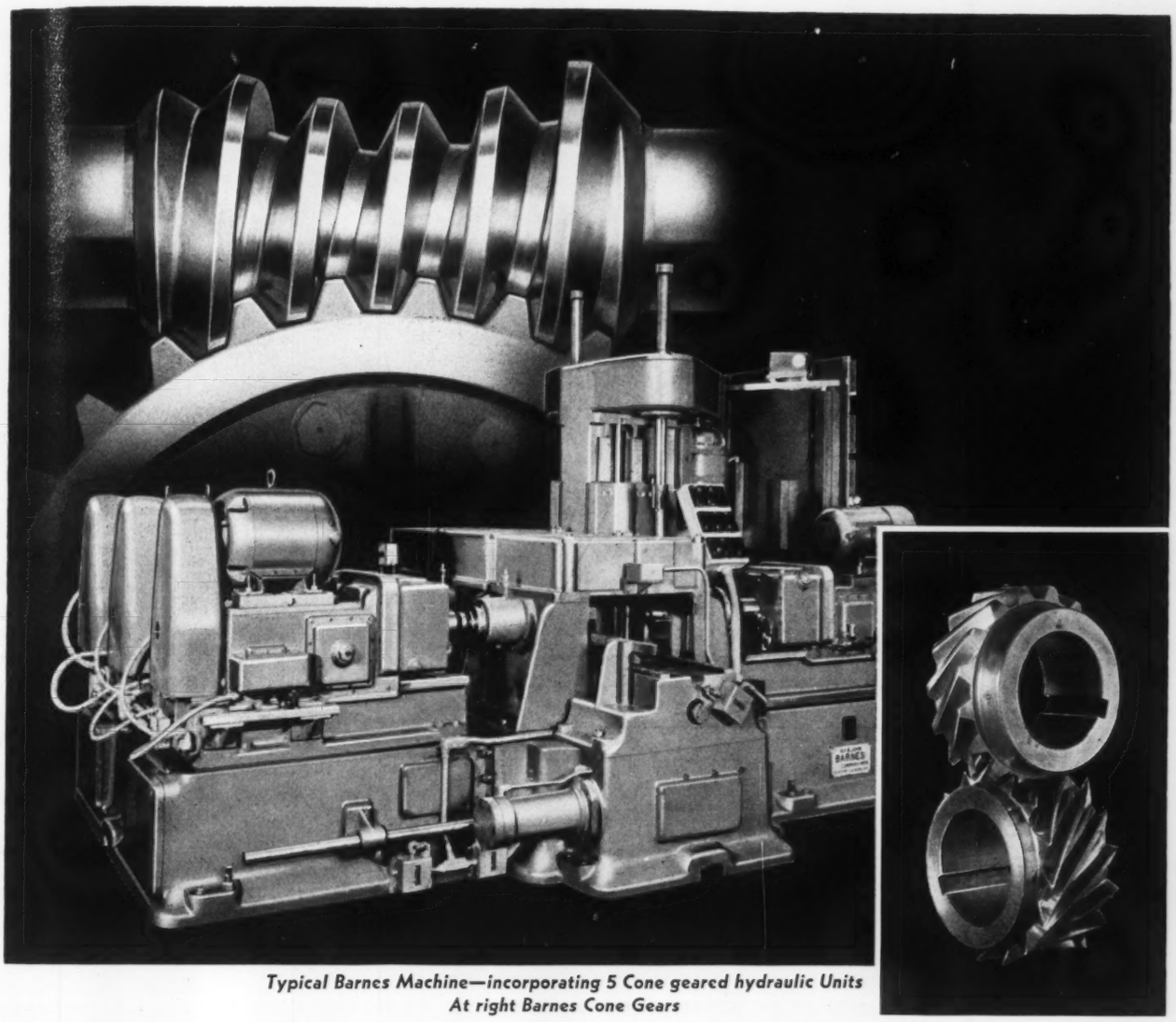


Fig. 5—Resistance welding is facilitated with electronic controls which finely adjust weld amperage

for spot welding aluminum is shown in *Fig.* 5. The electronic controls are at the left of the machine. An ignitron timer functions as a single pole switch in series with the primary of the welding transformer and in addition provides a method of "heat control." This latter feature enables fine adjustment of weld amperage without recourse to a tapped transformer.

The primary current is conducted by use of two

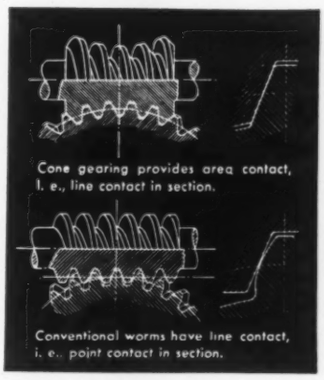


Typical Barnes Machine—incorporating 5 Cone geared hydraulic Units
At right Barnes Cone Gears

Barnes Cuts Size *with* Cone Worms

One reason, according to W. F. & John Barnes Company, why Cone gearing is used in its "Square Ram" hydraulic units, is that " . . . . . it allows us to incorporate our hydraulic system in a very limited space . . . " Cone gearing carries more load in smaller sizes because of its exclusive AREA CONTACT—extending the entire depth and substantial portion of the width of each worm and wheel tooth in engagement — and with more teeth in engagement.

In addition, however, Cone worm gearing contributes to another characteristic of machines driven with Barnes Units—freedom from tool chatter and jump. The process by which Cone gearing is made—generating exactly mating worms and wheels with hobs and cutters of exact mating capacity—results in a smoothness of operation heretofore unknown in the worm gear field. That is why the drive to the Barnes rapid traverse and feed pumps is so efficient and quiet even though the 1-1/15th to one ratio gearing is direct driven at 1750 rpm.


Cone gearing provides area contact, i. e., line contact in section.
Conventional worms have line contact, i. e., point contact in section.

CURRENT CONE OPERATING RANGES
Ratios . . . . . Low, 1 to 6; High, 150 to 1
Speed . . Low, 1/15 rpm.; High, 20,000 rpm.
Sizes (C. D.) Low, 5/8 in.; High, 27½ in.

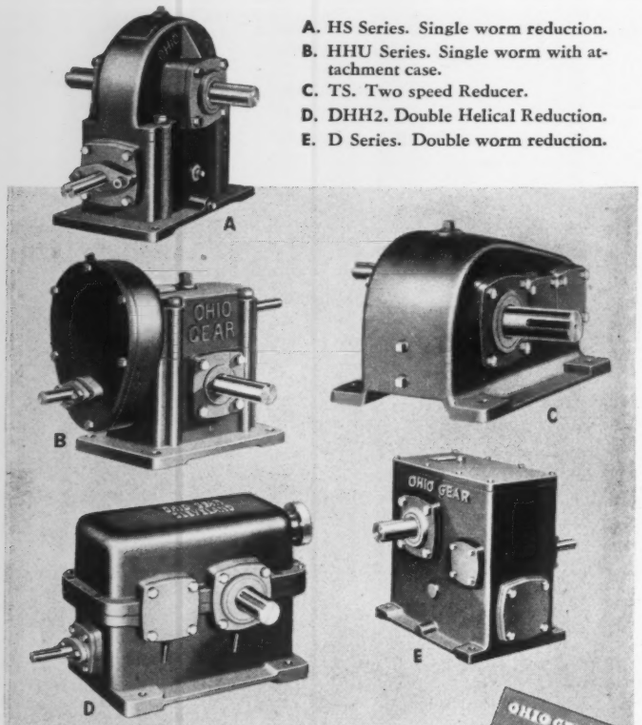
And finally, Barnes' freedom from service replacements of gears is not surprising. Cone worm and wheels — due to their method of generation — tend to re-generate the original form in service. And the contact surfaces ride on a film of oil—automatically maintained by the pumping action of the entering worm teeth.

MICHIGAN TOOL COMPANY, 7171 E. McNICHOLS RD., DETROIT, MICHIGAN

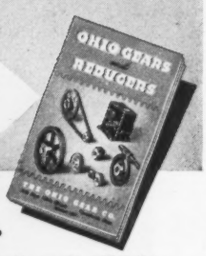
FOR YOUR REDUCER NEEDS-

Here are only a few of the single, double, helical, two and four speed reducers you'll find in the complete Ohio line. Check them against your needs . . .

A. HS Series. Single worm reduction.
B. HHU Series. Single worm with attachment case.
C. TS. Two speed Reducer.
D. DHH2. Double Helical Reduction.
E. D Series. Double worm reduction.



Our complete line of reducers, gears, etc., is shown in our new catalog No. 39. Send request on letterhead for your copy.



THE OHIO GEAR CO.

1338 E. 179th Street · Cleveland, Ohio

Representatives

*Los Angeles, Calif. J. W. Minder Chain & Gear Co., 927 Santa Fe Avenue.
*San Francisco, Calif. Adam-Hill Co., 244-246 Ninth Street.
Indianapolis, Ind. A. R. Young, 518 North Delaware Street.
Pittsburgh, Pa. Industrial Sales & Engineering Co., Box 8606, Wilkinsburg, Pa.
Detroit, Mich. George P. Coulter, 322 Curtiss Building.
Buffalo, N. Y. F. E. Allen, Inc., 2665 Main Street.
New York City, N. Y. Patron Transmission Co., 154-156 Grand Street.
New York City, N. Y. E. G. Long Co., 50 Church Street.
Grand Rapids, Mich. W. H. Slaughter, 419 Oakdale St., S. E.
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Louisville, Ky. Alfred Halliday, 330 Starks Building.
Salt Lake City, Utah. A. O. Gates, 619-629 South Fifth West Street.
*Stocks carried.

OHIO GEARS

mercury pool cathode vacuum tubes which are made of metal and water-jacketed. Two of these ignitron vacuum tubes are required for full wave conduction and each tube must be "fired" each half cycle by use of an igniter or spark plug. Once each tube is ignited it will continue conducting through the remainder of the half cycle for which it was ignited. Each igniter lead is supplied with current from two thyratron vacuum tubes connected in series. One each of these tubes is referred to as the "time control tube" and the other, the "heat control tube." Both thyratrons associated with the same ignitron must be conducting before ignition will take place.

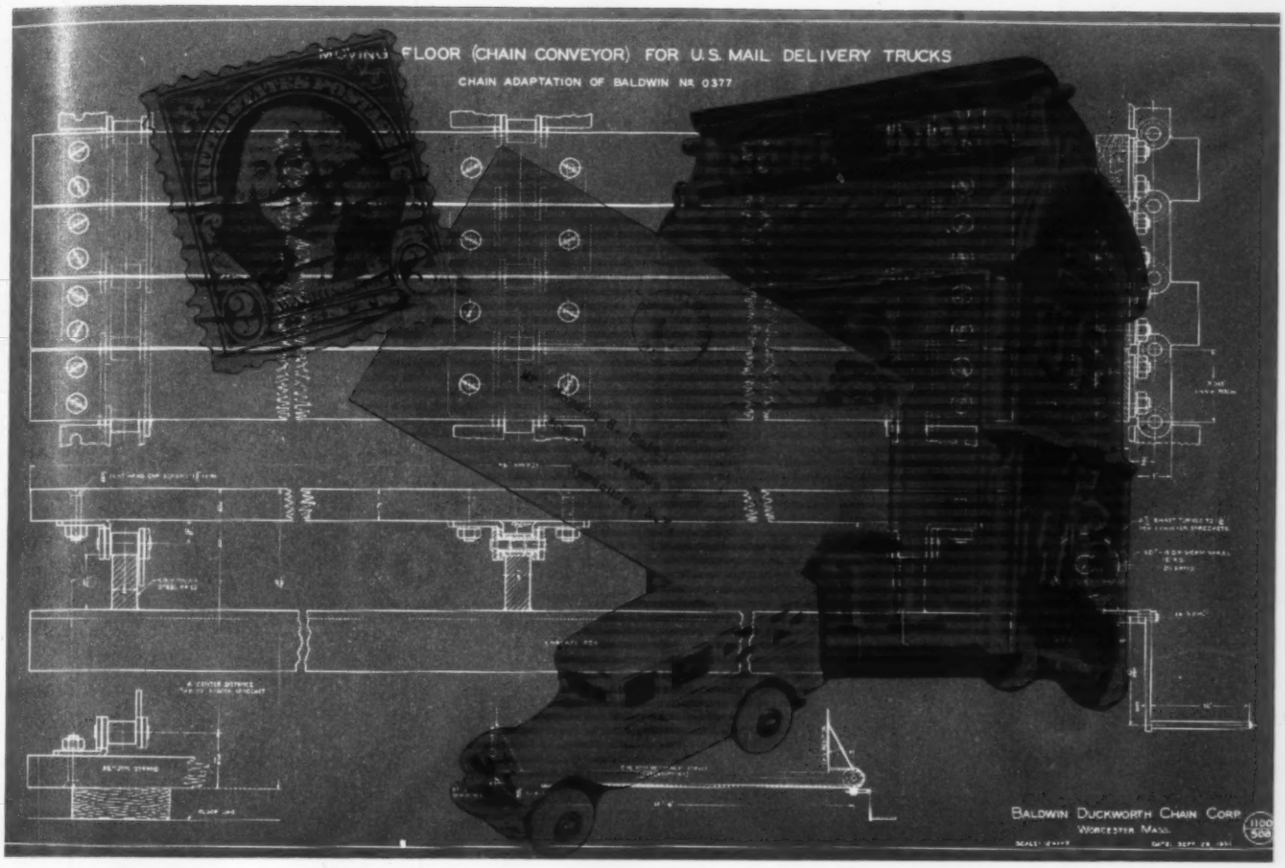
In addition three smaller thyratron tubes control the timer tubes. These are called the kick tube, start tube and stop tube. The kick tube operates continuously and serves to control the starting point of the first half cycle of a weld and acts as a power factor adjustment. At the same instant the start tube ionizes and discharges a stored quantity of electricity through a variable resistance. When the potential of this charge is reduced to a low value the stop tube is ionized and blocks the action of the start tube. Therefore, each main thyratron tube is in itself controlled by the action of the smaller tubes.

Electrical Angle of Tubes Varied

A phase shift arrangement including resistance and reactance is provided to vary the electrical angle at which each heat control tube will complete the ignition circuit to each ignitron. With a "heat control potentiometer" it is possible to delay the ignition of each ignitron every half cycle and produce a series of half-wave loops with discontinuity between them.

If, in application, recommended practices are followed these controls should perform trouble-free. Because most tubes conduct only a few millionths of an ampere, proper mounting and shortest possible leads to the control cabinet should be used. This is especially true where high-speed operation is required. Optical systems should be designed so that the greatest possible amount of light is interrupted, extraneous light is excluded from the scanning field, and so located as to avoid collection of dust and dirt. Provisions should be made for keeping the controlling object within the light beam. For temperature operation by radiated light, the receiver should be as close as possible to the hot body. Precautions against overheating may be provided with a water-cell filter. Negative operation is desirable for system protection against failure of any part.

Machine Design gladly acknowledges the assistance of the following companies in the preparation of this article: Electronic Control Corp.; American Car & Foundry Co.; Bristol-Myers Co.; The Quickwork Co.; Redson-Rice Corp.; Hudson Sharp Machine Co.; Haysen Manufacturing Co.; Seversky Aircraft Corp.

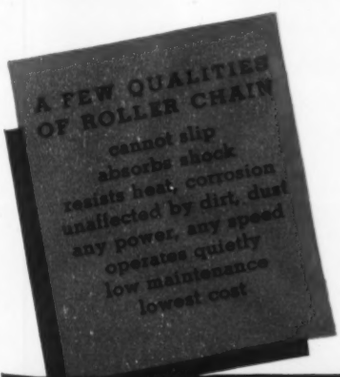

FLOOR (CHAIN CONVEYOR) FOR U.S. MAIL DELIVERY TRUCKS
CHAIN ADAPTATION OF BALDWIN NR. 0377
BALDWIN DUCKWORTH CHAIN CORP.
WORCESTER MASS.

Mails Move FASTER Now

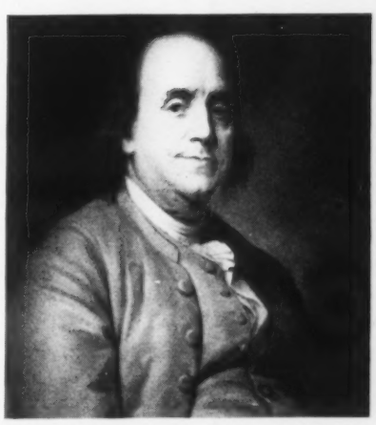
To busy Baldwin engineers daily come requests for aid on knotty roller chain design problems. Recently, potent United States Postal Service enlisted Baldwin's skill to help speed up mail truck deliveries.

Baldwin engineers came through with recommendations and detailed working drawings (see blue print above). This ably designed chain floor conveyor for delivery trucks keeps United States mails on the move faster, surer, cheaper. It is a typical example of how specialized Baldwin knowledge benefits industry.

No idle talk is the plea that you bring your conveying problems to Baldwin. Its engineering facilities are available so that you may enjoy the advantages of more modern design and greater economy from the application of roller chain to your own needs. Far sighted, modern-minded industrialists will tear a leaf from the government's notebook—call the B-D Man today.



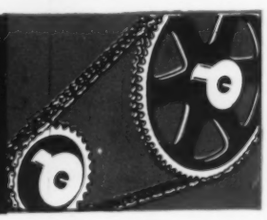
BALDWIN-DUCKWORTH CHAIN CORPORATION
SPRINGFIELD, MASS.
Factories at Springfield and Worcester, Mass.



"Look before or you'll find yourself behind"

When Ben Franklin wrote this back in 1735 he might have been giving advice to 1939 manufacturers. It still pays to look ahead—and when you really "look ahead" in power transmission and conveying you specify Baldwin Roller Chain.

BALDWIN-DUCKWORTH



MOTORS

of Special Design

TEXTILE loom motors; splash-proof motors for dairies and wet places; vertical motors—these are only a few of the special designs Peerless has available. Peerless builds special motors for grinders, pumps and equipment of all kinds Range of sizes ⅛ to 10 horsepower Send us your drawings and specifications.

THE Peerless ELECTRIC CO.
WARREN, OHIO

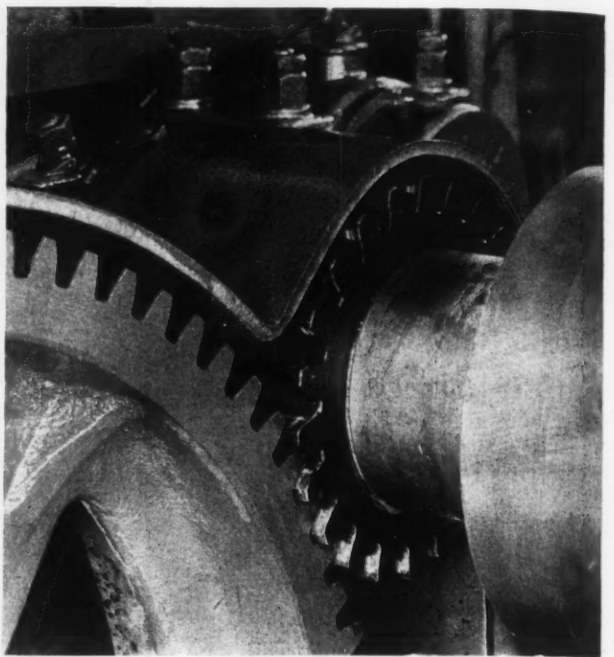


Photo courtesy Formica Insulation Co.

Fig. 1—Nonmetallic gears absorb shock and reduce noise transmission

Nonmetallic Gears and Couplings Deaden Vibration

NONMETALLIC gears and couplings are the answer to many unusual drive problems where metals are deemed unsuitable or where plastic materials exhibit a more desirable characteristic such as quieter operation. Constant improvements in these materials, making them more resistant to wear etc., have resulted in a steady increase in utility and application to machines.

Plastics are utilized in the design of many couplings, particularly for resilient couplings between the motor drive and machine. Under conditions of nonuniform loads, a medium to absorb some of the energy in the rapid changes of angular velocity is highly desirable to system stability.

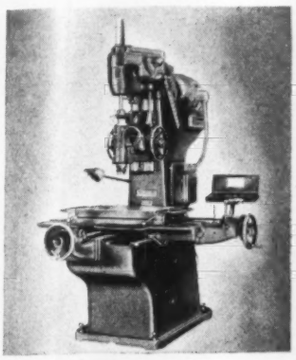
There are certain singular properties of plastics, which make them suitable for nonmetallic gears. These properties are discussed in the following.

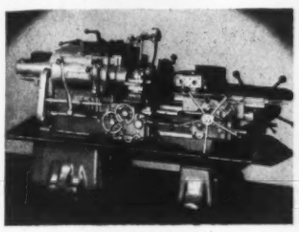
LOW MODULI OF ELASTICITY: Deflection under applied stress is an inverse function of the moduli of elasticity. Low moduli impart the quality of resiliency to gear applications, a property important in the absorption of shock or impact loads upon gear teeth.

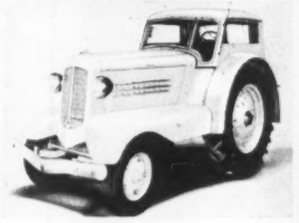
WATER LUBRICATION: In many instances machine

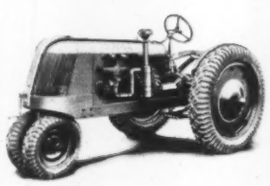
Rockford Industrial Clutches and Power Take-Offs

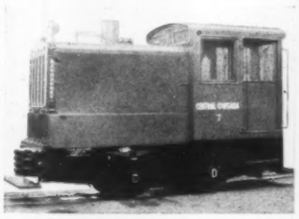
Time-Tested Power Transmission Control for Modern Machinery











Pullmore Clutches are unexcelled for applications requiring a multiple disc clutch in relatively small space. They are used effectively as main drive clutches carrying all the load; as auxiliary clutches controlling individual units; and in power take-off mechanisms to operate various attachments. Ideal for machine tools, road working equipment, wire spooling machines, cranes, industrial trucks, packaging machinery and a wide variety of other industrial applications. Pullmore Clutches are available in single and double types, for operation in oil or dry, in capacities from 1 h.p. to 75 h.p. at 500 r.p.m.

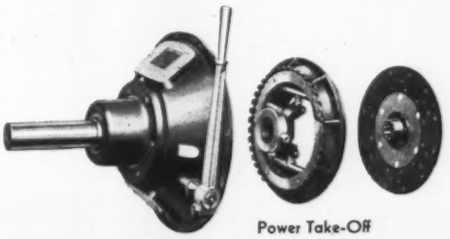
Rockford Spring-Loaded Clutches operate like automobile clutches; are the result of long experience in manufacturing these products. Rockford Spring-Loaded Clutches are generally interchangeable with corresponding Rockford O-C Clutches, and have similar applications, depending on service and design requirements.

Rockford O-C (Over-Center) Clutches remain in or out of engagement until operator shifts control lever or pedal. Exclusive anti-friction roller cams and other features make O-C operation extremely easy; promote long service without adjustment; exert heavy pressure uniformly with cushioned action; give smooth, positive engagement. Back plate carries majority of clutch weight; adds to fly-wheel effect.

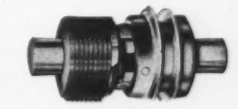
Rockford Spring-Loaded and O-C Clutches are available with single or double drive plates, for operation in oil or dry, in sizes from 6" to 20" diameter for transmitting from 2 h.p. to 80 h.p. at 100 r.p.m.

Rockford Power Take-Offs are built in a complete range of sizes, with O-C Clutches, for application to standard S.A.E. fly-wheel housings. Available plain as illustrated, or with gear reduction. Shaft, type of bearings, and other details depend on size of unit and operating conditions.

Engineering Service. The services of our engineering department are available, free, for developing new Rockford Clutch applications. Write today for descriptive literature and information. Specify dependable, time-tested Rockford Clutches for efficient low-cost power transmission and control.

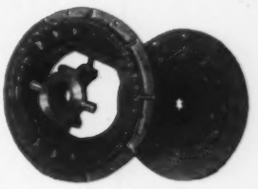


Power Take-Off

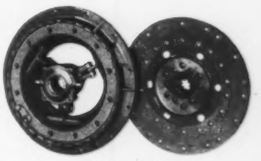


Single-Type Pullmore

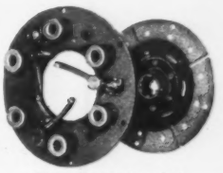
Double-Type Pullmore



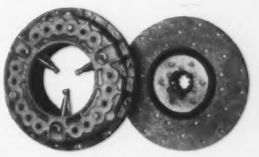
12" Over-Center Bronze Bearing



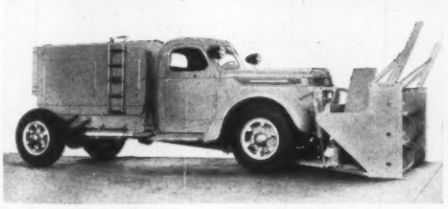
14" Over-Center Ball Bearing

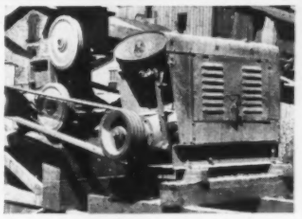


9" I.I. Spring-Loaded



15" T.T. Spring-Loaded





ROCKFORD DRILLING MACHINE DIVISION

of Borg-Warner Corp., 304 Catherine Street, Rockford, Illinois

Brad Foote
REDUCERS

Brad Foote line in Order Shown
HEAVY DUTY WORM GEAR
single—41 ratios—3⅝ to 1—to 100 to 1.—double larger
SPIRAL BEVEL GEAR
ratio 1¾ to 1—75 HP 500 RPM, constant duty, pressure lubrication
OIL WELL UNIT
single—Helical—80 HP 396,000 inch pounds torque—all types for oil fields
HERRINGBONE T. R. A.
triple reduction right angle—17 ratios—60 to 1 to 283.5 to 1.
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Reducer Manual
Ratings at a glance — new thoughts on power transmission problems
write for it
OIL LEVEL
OIL DRAIN
FOOTE GEAR WORKS INC.
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Cicero, Illinois

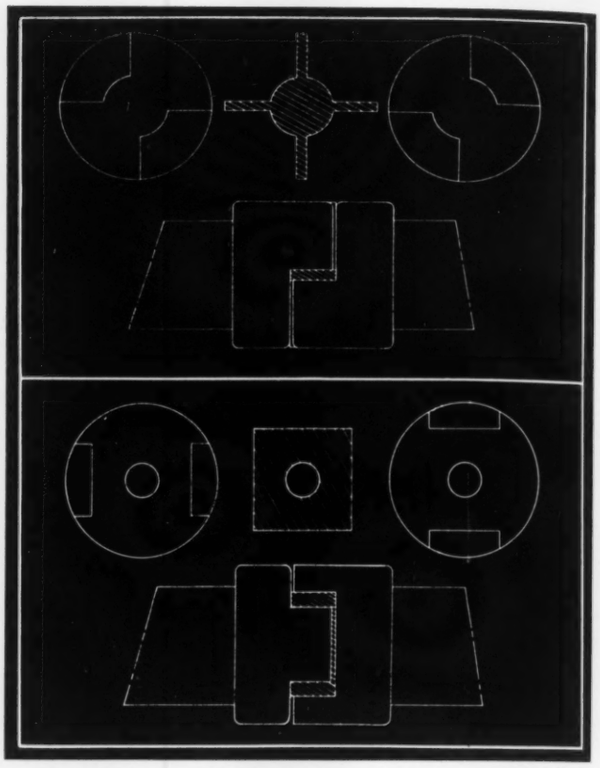


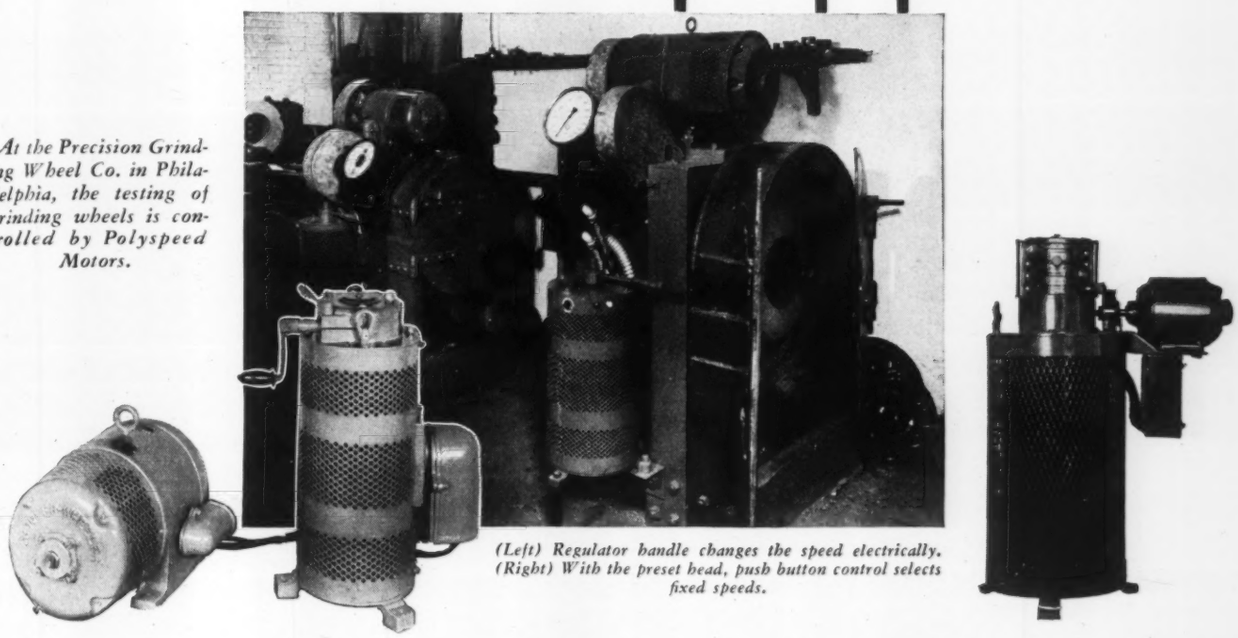
Fig. 2—Top—Diagram of coupling with nonmetallic insert under direct compressive stress. Fig. 3—Above—Nonmetallic insert with compression and shear stresses

designers have taken advantage of the fact that water lubrication is entirely suited to organic plastic materials, and have made provisions for lubricating in that manner. There are numerous power drives in which either the driving or driven member is in contact with some aqueous solution. Whereas some metals may corrode under these conditions, the plastic usually proves satisfactory. Some of the best known applications are in chemical equipment such as electroplating tanks and drives for tumbling barrels. The gear drive often extends into the solution but this is no handicap to a laminated phenolic material. The paper and meat packing industries are among the larger users of nonmetallic gears. Graphite impregnated, canvas base laminated phenolic plastic gears may offer certain advantages where even water lubrication is scarce.

INSULATING QUALITIES: Plastic materials are thermal and electrical insulators. Many applications in machine drives make it desirable to insulate motors from the equipment to be driven. One notable example is the drive in electric dry shavers or hair clippers, where the rotating armature is insulated electrically from the metal parts which contact the body. The low thermal conductivity of the plastic is often an additional advantage realized in such designs.

QUIETNESS OF OPERATION: The silent operation of nonmetallic gear drives is well known and has been a

3800 firms have already inquired about this new ALTERNATING CURRENT polyspeed MOTOR



At the Precision Grinding Wheel Co. in Philadelphia, the testing of grinding wheels is controlled by Polyspeed Motors.

(Left) Regulator handle changes the speed electrically. (Right) With the preset head, push button control selects fixed speeds.

Here is 1939's answer to the problem of adjustable motor-speed control. The rightness of the Crocker-Wheeler *Polyspeed* Motor was instantly recognized. From the appearance of only one advertisement, in a list of business papers, 3800 firms wrote in for "the full details immediately."

We would like to send them to you, too. Meantime, here are the high spots . . . *Polyspeed* is an adjustable-speed motor for operation on alternating current; built in 1, 2, 3, 5 and 7½ horsepower sizes—for 220, 440 or 550 volts; 3 phase, 60 cycle operation . . . *Polyspeed* provides fully continuous speed regulation—with no rheostat losses; high starting torque—300 or 400%, if desired; regenerative braking; remote and automatic control of speed, if desired.

Polyspeed permits an infinite number of speeds. With hand control—turning the regulator handle changes the speed electrically. Or—with preset head—push button control permits selection among 2 to 6 fixed speeds.

We invite you to write—on your business or professional letterhead—for complete and illustrated data on *Polyspeed* Motors — pioneered by Crocker-Wheeler. And on any of the lines of motors and generators listed below—or on flexible couplings—we would also welcome your inquiry.

ADJUSTABLE SPEED

When adjustable-speed motors are required, consult Crocker-Wheeler. A great deal of experience is at your service—long years of building D.C. adjustable-speed motors (speed adjusted by field control or by voltage control); of building slip-ring, variable-speed motors, or squirrel-cage multispeed motors. The addition of the A.C. *Polyspeed* Motor places us in position to make unbiased recommendations for any application. *If you have an adjustable-speed problem, consult Crocker-Wheeler.*

CROCKER-WHEELER

POLYSPEED MOTORS
1 TO 7½ HP.

DIRECT CURRENT MOTORS
⅛ TO 5,000 HP.

POLYPHASE INDUCTION MOTORS
¼ TO 10,000 HP.

SYNCHRONOUS MOTORS
15 TO 10,000 HP.

CROCKER-WHEELER
TRADE MARK REG. U.S. PAT. OFF.

DIRECT CURRENT GENERATORS
UP TO 7,500 KW.

ALTERNATING CURRENT GENERATORS
UP TO 10,000 K.V.A.

MOTOR-GENERATOR SETS
UP TO 7,500 KW.

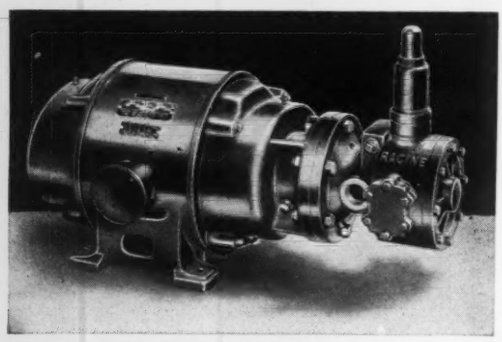
FLEXIBLE COUPLINGS
UP TO 200 HP.

50 YEARS OF PIONEERING

CROCKER-WHEELER ELECTRIC MFG. COMPANY, AMPERE, NEW JERSEY

RACINE

VARIABLE VOLUME HYDRAULIC PUMPS



RACINE Pumps—available for direct motor mounting —standard flange mounting 3 to 10 H. P.

RACINE Pumps are of the radial vane type with the exclusive "RACINE" feature of balancing the vanes hydraulically at all pressures. This prevents wear and friction loss. Constant pressures maintained automatically without by-passing of oil, at great saving of horse power and minimum oil heating. Foot type or flange mountings available in sizes 2000, 4000, and 6000 cu. in. per min. Write for catalog P-10.

RACINE HYDRAULIC VALVES

Ruggedly built with complete hydraulic balancing of the interior parts. Accurate grinding and machining insure a minimum of interior leakage. The standard valves shown here are subject to a wide range of interior modifications to fit any circuit.

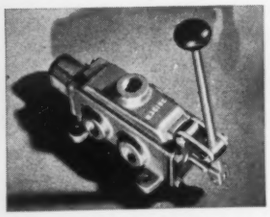


Fig. 1

Fig. 1 RACINE lever operated, spring centered, 4-Way valve.

Fig. 2 RACINE Pilot valve, mechanical or manual control.

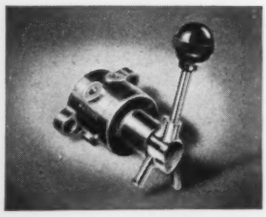


Fig. 2

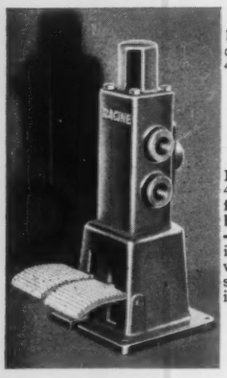


Fig. 4

Fig. 3 RACINE direct operated, 4-Way stem valve.

Fig. 4 RACINE 4-Way valve—foot operated in both directions—Single treadle is furnished when valve is spring returned in one direction.

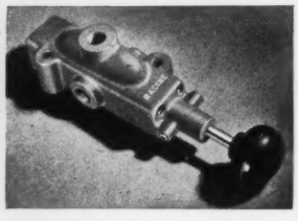


Fig. 3

A wide selection of standard and special valves and controls offer a complete hydraulic service to engineers. Write for catalog V-10

"Standard the World Over"

RACINE TOOL & MACHINE CO.

1773 State Street **Racine, Wis.**

prime reason for their introduction on power drives in industrial locations where prevailing noise may contribute to undesirable working conditions. As the teeth of metallic gears become worn, or dirt and grime make their appearance, the noise level increases. Plastic gears and pinions minimize this tendency by their ability to absorb shock and exhibit a certain degree of resiliency. Automobile nonmetallic timing gears have long been standard equipment. Another illustration is in a food mixing machine employing two nonmetallic gears operated from a worm drive. Without nonmetallic gears the noise level would be a serious objection.

OPERATION IN ABRASIVE ATMOSPHERES: Unlike the metals, plastics will actually bury small abrasive particles on their surface, under pressure, nullifying the high destructive action of abrasives on gear teeth. This quality makes plastic gears particularly suitable for sand blast machines and other places where abrasives are encountered.

EASE OF FABRICATION: The majority of nonmetallic gears are machined from laminated phenolic plastic stock, punched from thin sheet stock of plastic materials, or molded directly from powdered resin. Where the pieces are large and the demand small, the most economical procedure of fabricating gears or pinions is to machine from laminated phenolic gear stock. For high production requirements, however, there are other expedients. One of the most satisfactory is to punch the gear directly from sheet stock. As there is a limit to the thickness of stock that may be punched suitably at room temperature, sizable gear widths may be built up from several punchings bolted or riveted together either with or without metal reinforcing plates on the end. Another expedient is to mold directly from powder, using a shredded textile filler in the phenolic resin binder. The materials manufacturers have spent much time in the development of a suitable composition to insure uniform

(*Concluded on Page* 56-S)

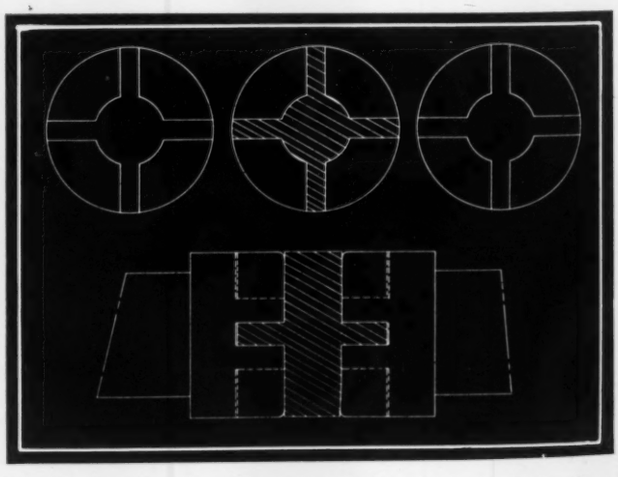
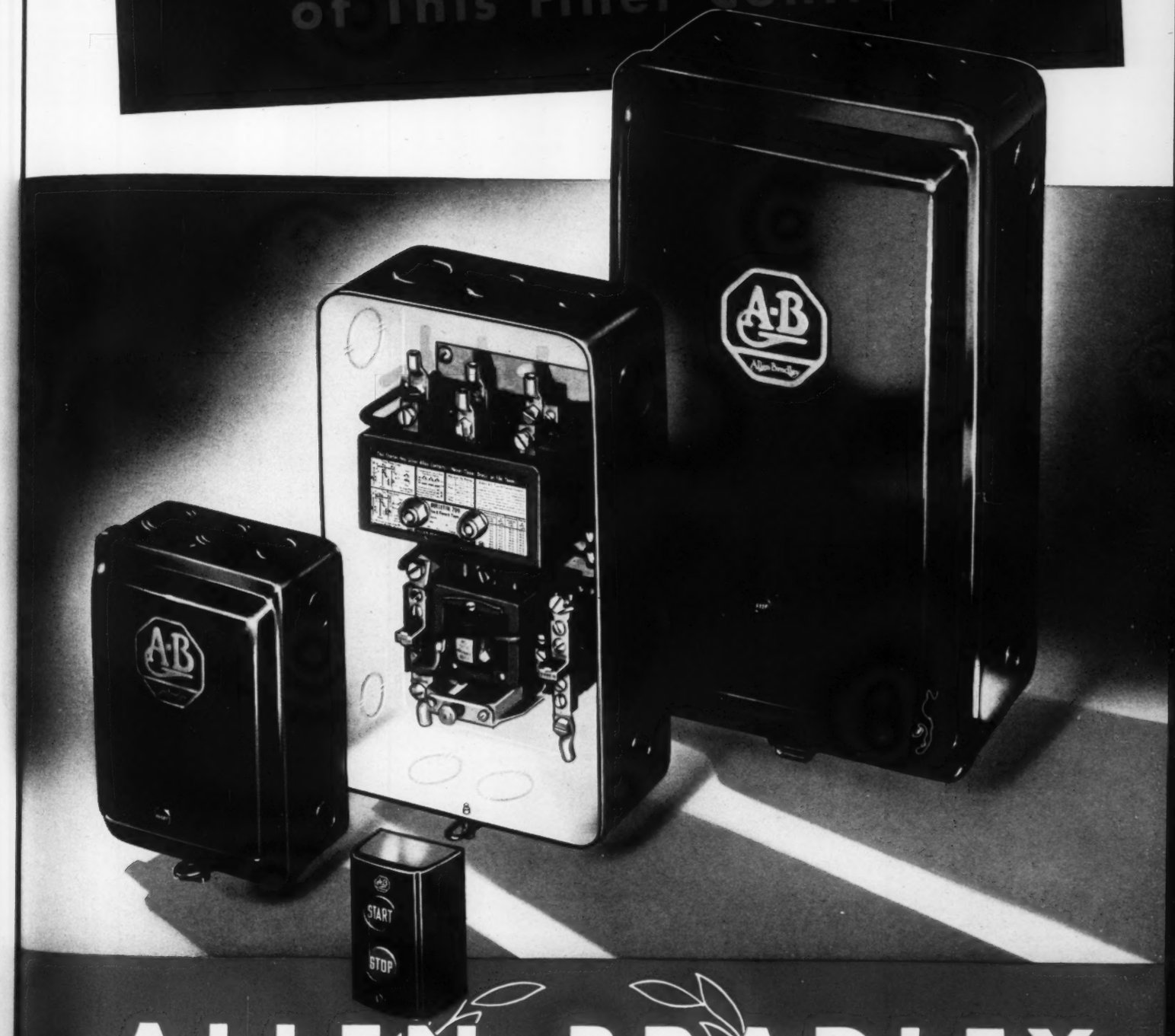


Fig. 4—Coupling using insert under shear and bending stresses

Give Your Machines
the **EXTRA SALES ADVANTAGE**
of This Finer Control!



ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

The simple, rugged construction, the attractive modern appearance, and the time-tested reliability of Allen-Bradley motor controls make these units a valuable asset in selling your machines.

"TROUBLE? -Not with Allen-Bradley Control"

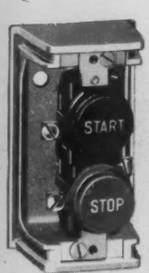
"I always thought motor starters were the 'weak links' on our machines. But since we installed those Allen-Bradley solenoid starters, I've changed my ideas a lot. These starters are in almost continuous operation, yet they never give us any trouble. Believe me, when we need more starters, I'm going to be sure they're Allen-Bradley!"

A NEW Push-Button Station

New in Styling

Note the clean, modern appearance of this new Bulletin 800 push-button station. With its glossy black, heavy bakelite cover and sturdy die cast frame, it is the ideal "start-stop" station for any general purpose application.

New in Ideas



The silver-to-silver contacts are located where dust and dirt must do tricks to get at them. Yet the terminals could not be more accessible. Removing the cover completely exposes the push-button unit, making the wiring of the button a "cinch." Ask your Allen-Bradley representative to show you this new A-B push-button station.

THE MOTOR STARTER THAT'S *TROUBLE-FREE*

Simple Construction

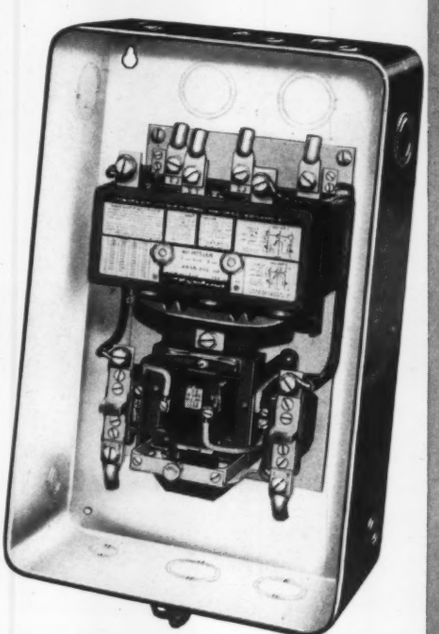
No bearings, no pivots, no complicated mechanisms—that's the secret of the Allen-Bradley solenoid starter's long and trouble-free performance.

No Contact Maintenance

You never have to file the double break, cadmium silver alloy contacts. That's one reason why they last many times as long as ordinary contacts.

No Unnecessary Shutdowns

Because of the efficient solenoid action and straight-line motion, welded contacts and shutdowns caused by poor line voltage conditions are avoided.



Bulletin 709, Size 2, across-the-line solenoid starter for squirrel cage induction motors.

Rugged Parts

This simple starter has few parts. They are extremely rugged and will withstand abuse.

Overload Protection

Two eutectic solder overload relays protect the motor from sustained overloads. They are reset by pressing a small button on the cabinet front.

Send for "The Story of the Solenoid Starter"

Allen-Bradley Company
1333 S. First Street
Milwaukee, Wisconsin

Please send me a copy of "The Story of the Solenoid Starter."

Name ----------

Company ----------

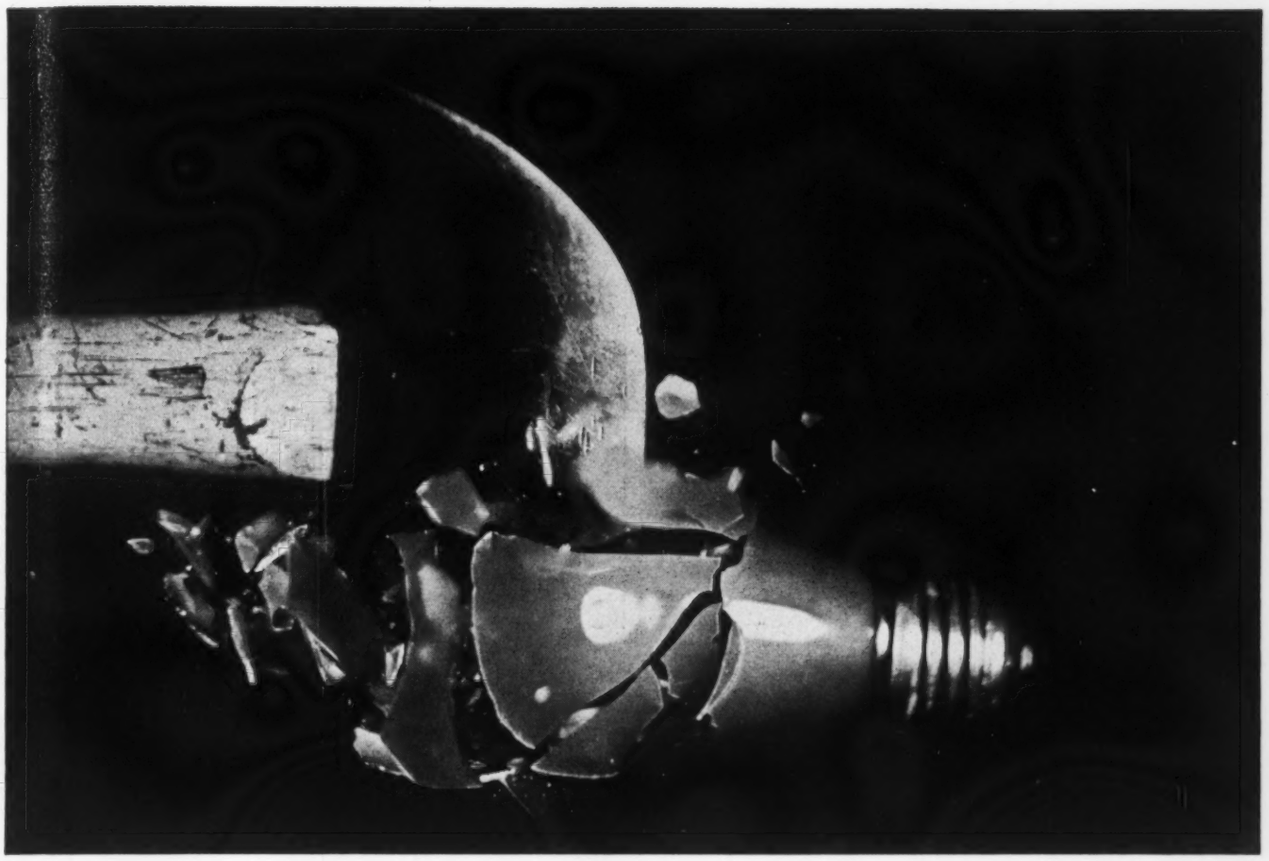
Street ----------

City ---------- State ----------

ALLEN-BRADLEY

SOLENOID MOTOR CONTROL

QUALITY



Does It STOP Motion?

THIS unretouched single-flash photograph shows more effectively than a thousand words can tell, how the *new* Type 631-B STROBOTAC and the *new STROBOLUX* stop motion. The electric light bulb is shattered yet each particle of glass was 'stopped' before it could fly out of range of the camera.

These General Radio instruments . . . the STROBOTAC and the new STROBOLUX . . . can stop motion for you in the most complicated machine. For visual observation the STROBOTAC will freeze motion up to 100,000 *rpm*. . . . it will also show any cyclic revolving or reciprocating device operating as fast as 100,000 rpm in s-l-o-w motion . . . *as slow as a fraction of an rpm!*

TYPE 631-B STROBOTAC

The STROBOTAC has been improved in a number of ways to increase its usefulness as a speed-measuring or motion-stopping device. The rpm scale is more conveniently located on top of the case where it can be read more easily. The overall accuracy has been increased to ± 1%. The control switch has been simplified so that it can be set without the slightest confusion. Terminals are provided for making connection to the STROBOLUX where additional light is desired.* With all of these improvements the price of the STROBOTAC remains only $95.00.

● **WRITE FOR BULLETIN 400 FOR COMPLETE INFORMATION**

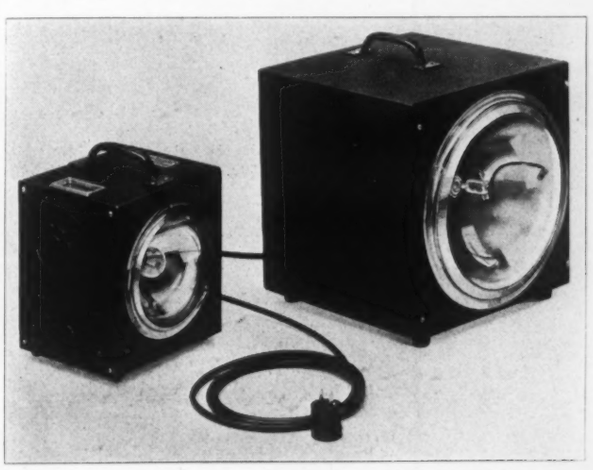
GENERAL RADIO COMPANY, Cambridge, Mass.

Branches in New York and Los Angeles

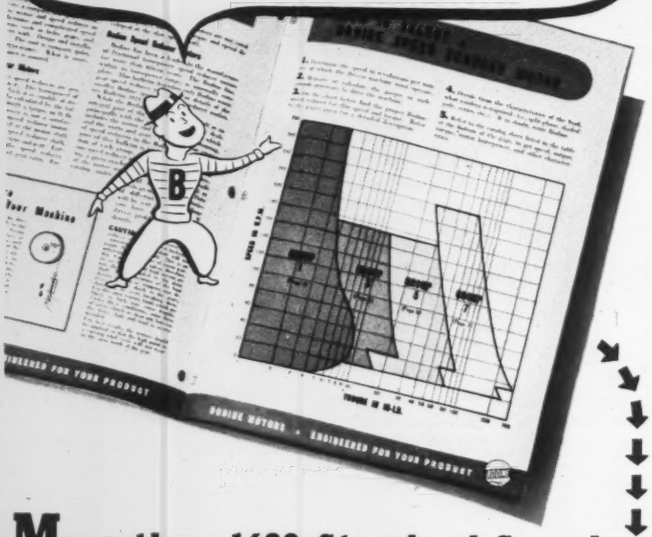
NEW TYPE 648-A STROBOLUX

This instrument is a new development. It comprises a built-in power supply and a large lamp with a 9-inch reflector, furnishing about 100 times as much light as the STROBOTAC. It is for use when relatively large areas are to be illuminated or when single-flash photographs, taken over limited areas, are wanted. It can be flashed up to 6,000 times per minute by means of the STROBOTAC with which it must always be used.* The Type 648-A STROBOLUX is supplied complete with the necessary line and connecting cords. Price: $175.00.

****Your present Type 631-A STROBOTAC will be equipped without charge, with an output jack for connecting the STROBOLUX if the Type 631-A instrument is returned to the factory when ordering the STROBOLUX.***



Here's how to find the SPEED REDUCER MOTOR for your Machine



More than 1600 Standard Speed-Reducer Motors from 1/2000 to 1/6 h p

Do you know the speed and torque needed to drive your machine? Then, this simple chart will tell you the many types of Bodine motors that you can use. Simply mail the coupon for Bulletin 1022.

No other manufacturer has so many standard fractional horsepower speed reducer motors. Bodine offers shaded pole, series, split phase, shunt, polyphase, capacitor, synchronous, and governor motors . . . motors with sleeve bearings and ball bearings . . . motors with standard and special mountings.

Bodine motors are built to give long years of service with minimum maintenance and attention. They are reliable, smooth running, quiet, and efficient. There is a Bodine motor, with or without a speed reducer, to fit your special requirements.

BODINE

Bodine Electric Co. 2258 W. Ohio St., Chicago, Ill.

Please send me your new bulletin on speed reducer motors.

Name.....

Company.....

Address.....

BODINE MOTORS

ENGINEERED FOR YOUR PRODUCT

(*Concluded from Page* 52-S)

penetration of resin binder into the filler content, so that maximum impact resisting qualities will be available in the gear teeth.

The requirement of low creep under stress for gears eliminates thermoplastic materials which exhibit relatively large cold flow, but the thermosetting phenolics are applicable. Canvas base reinforced phenolics have been among the most suitable, with a flexural strength in the neighborhood of 20,000 pounds per square inch and a modulus of elasticity around 1,000,000.

Couplings Absorb Shock

In connection with nonmetallic couplings, laminated phenolics and rubber have seen extensive application. When coupling designs call for high resiliency, rubber has often proved acceptable though it may lack permanency of characteristics. The presence of grease and oil in the drive may necessitate the introduction of synthetic rubber which does not have as pronounced a tendency to swell in the presence of oils as natural rubber.

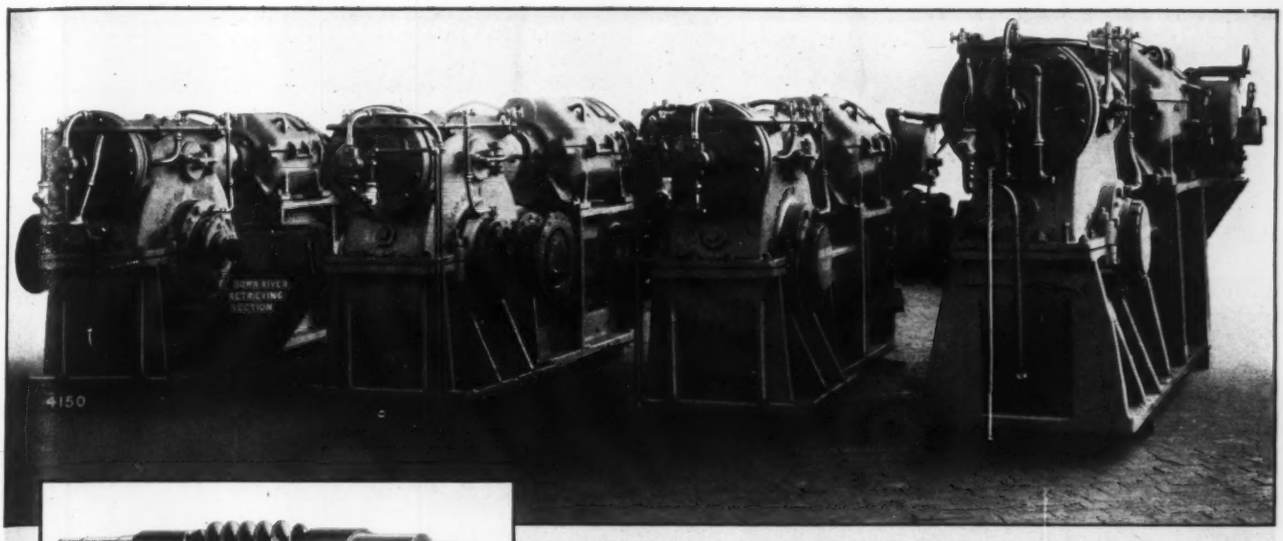
Couplings with nonmetallic inserts are applicable to machine drives for the following reasons.

A certain degree of flexibility is provided in the coupling to absorb partially the loads due to rapid changes in angular velocity. This is of particular importance in designs in which the loads vary frequently from maximum to minimum. Due to the energy absorptive characteristics of certain nonmetallics, stresses in rotating parts may be reduced by a proper application of coupling between driving and driven members.

Couplings may have to be of an electrical insulating material to reduce shock hazard from an electric motor drive. The same reasons that prompt the selection of nonmetallic gears in a drive—for their insulating qualities—would also apply to couplings.

The presence of nonmetallic materials will reduce the noise which may accompany some motor drive couplings due to slight play between driving and driven members. A few designs are shown in the accompanying sketches in which these materials are introduced between the two halves of the coupling. Machined pieces of laminated phenolics are generally preferred for their shock-resisting qualities. Rubber may be suitable for some designs, however, as in a coupling in which the forces upon the nonmetallic members are compressive. In such applications quieter drives ensue when rubber replaces laminated phenolic members.

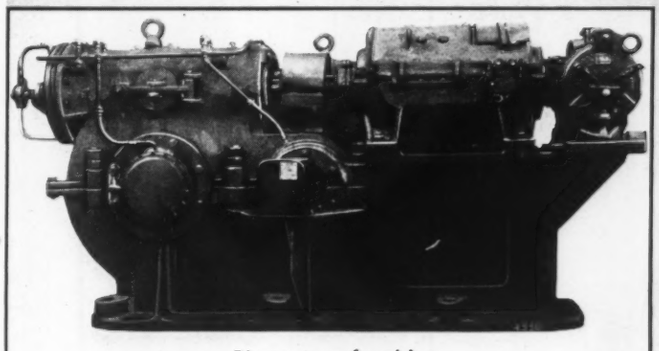
In this review of nonmetallics as applied to gears and couplings, the utility of these materials to machine design problems is discussed. Often what may appear to be an unavoidable handicap in drive problems, may be circumvented through the choice of the correct material.



● Steel mill machinery constructed by Treadwell Engineering Company, in which De Laval worms and worm wheels are incorporated. At the left is a drive for a hot bed retrieving section, 70 ratio, 20 in. centers; the next two are drives for pilers, same size gears, 40 ratio; while at the right is a hot bed pusher drive, 24 in. centers, 13½ ratio.

Settle the Drive Question

CHOOSE DE LAVAL WORM GEARS



–Bloom transfer drive.

★ The De Laval Worm Gear Engineers will gladly submit data and suggestions upon learning of your particular requirements.

DESIGNERS of special steel mill and other machinery save their own time and energy and insure satisfaction to their clients by taking advantage of the long experience (since 1901) of the De Laval Steam Turbine Company in solving exacting speed transformation problems.

De Laval Worm Gears have been worked out, built and tested in a great variety of heavy duty applications, and the De Laval Worm Gear Production Department has developed special methods and equipment for accurate and economical manufacture.

1105

DE LAVAL *Steam Turbine Co.*
TRENTON, N.J.

MANUFACTURERS OF STEAM TURBINES; PUMPS – CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT; CENTRIFUGAL BLOWERS AND COMPRESSORS; WORM GEARS; HELICAL GEARS; HYDRAULIC TURBINES AND FLEXIBLE COUPLINGS • • • SOLE LICENSEE OF THE BAUER-WACH EXHAUST TURBINE SYSTEM

ONLY A PEBBLE

But it did the Job!

● No larger than the stone from David's sling, yet in most fields of industry RELAYS by GUARDIAN possess the power to finish many a gigantic task, where, like Goliath's sword and shield, the mechanical method is too bulky, too slow, too power-consuming, to prevail against problems which RELAYS by GUARDIAN take in easy stride.

Are you seeking a way to improve your product, eliminate excessive mechanisms, make your machine more responsive, more efficient, less costly, more salable? . . . Then investigate RELAYS by GUARDIAN immediately.

Find out how innumerable types of control units may comprise small relays, discs, contact combinations, stepping switches, solenoids, auxiliary time delay, muting and holding relays, metal housings and brackets and other special parts . . . designed for compactness . . . every part fabricated, tested and assembled in one plant . . . Guardian's.

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GUARDIAN ELECTRIC
1621 W. Walnut St. Chicago • Illinois

Using Shell-Type Motors

(*Continued from Page* 27-S)

disadvantages to their use. What are these disadvantages?

The initial motor cost is a factor as is the resale value of the motors to an ultimate user. But more important is the extra cost involved in assembling the parts of the motors and in mounting them.

Application Factors to Consider

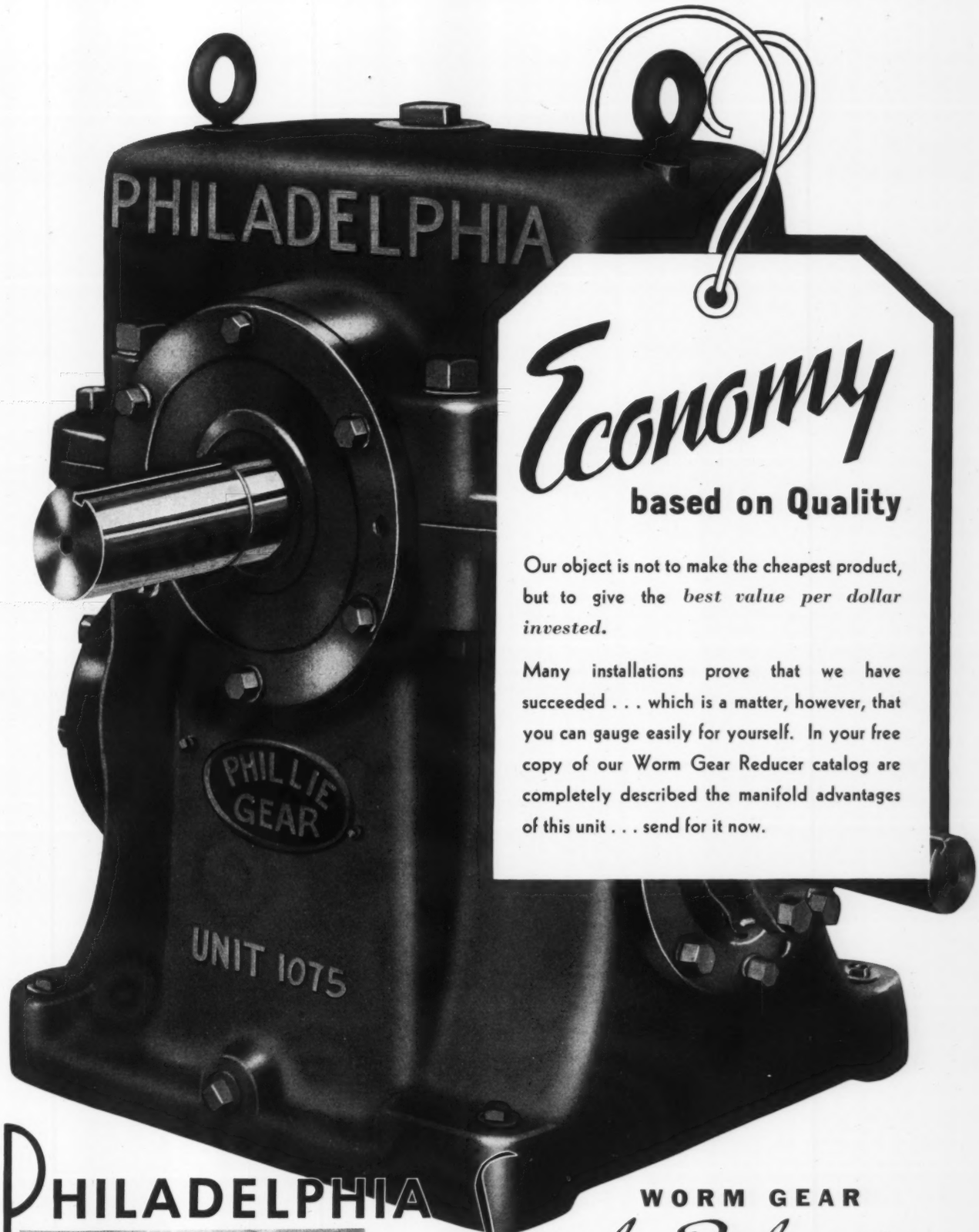
Behind this is the engineering responsibility which, as mentioned, has been transferred to the machinery manufacturer from the motor maker. It is difficult to estimate what the cost per machine may involve because the better the engineering the lower the expense. Because of this, a brief list of the major engineering problems is in order.

VENTILATION AND HEATING: Losses in a given motor cause heating and require means of cooling to keep within temperature limits for most economic life. For a continuous steady rating these losses are approximately $(H.P.)(1-\eta)/\eta$ where H.P. is the nameplate rating and η is the efficiency, regardless of speed. For a varying load they are $(R.M.S.)(1-\eta)/\eta$ where R.M.S. is the root-mean-square of the load. For a frequently starting, reversing or plugging duty cycle load the losses are a combination of root-mean-square, horsepower, load losses and the losses from changes of inertia. These losses from changes in inertia are approximately equal to the kinetic energy of the rotor for each start, three times this value for each plug and four times for each reversal.

Dissipation of these losses is accomplished by heat absorption and conduction of surrounding material, radiation and convection. Dissipation must come from the rotor as well as the stator, losses being divided equally according to a rough estimate on a steady speed load.

Only with motors of normal size with small horsepower ratings and loads, or equivalent short time ratings, will radiation and absorption alone be adequate to permit the motors being completely enclosed. Total enclosure without ventilation of a convection nature is, of course, the cheapest construction and more easily justifies shell-type motors.

Motors for torque applications such as hoists, clamping of cross rail heads and chucking commonly use this type of enclosure. Open end shields with no ventilation across the stator or around the rotor is little better, as far as cooling goes, than the totally enclosed, non-ventilated construction. Some manufacturers use a ribbed construction to aid radiation. This is beneficial, but care should be taken that calculations of radiation give adequate cooling. A large mass of surrounding material and a snug fit of stator



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Our object is not to make the cheapest product, but to give the *best value per dollar invested.*

Many installations prove that we have succeeded . . . which is a matter, however, that you can gauge easily for yourself. In your free copy of our Worm Gear Reducer catalog are completely described the manifold advantages of this unit . . . send for it now.

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Speed Reducers

PHILADELPHIA GEAR WORKS
Industrial Gears and Speed Reducers
ERIE AVENUE & "G" STREET, PHILADELPHIA, PA.

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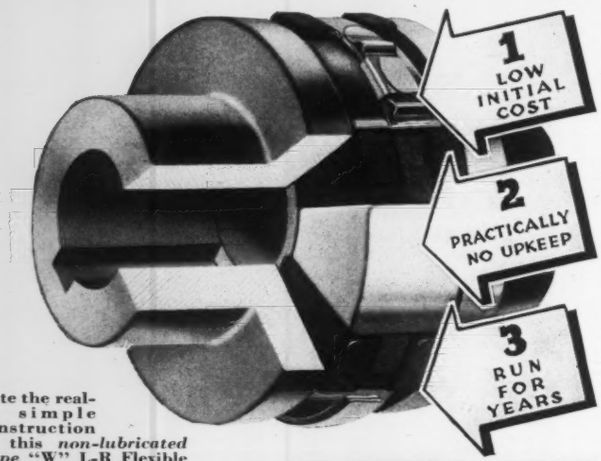
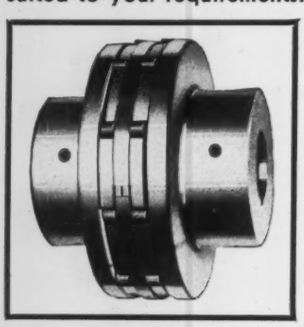


Note the really simple construction of this *non-lubricated Type* "W" L-R Flexible Coupling. Power is transmitted through individual free-floating load cushions.

L-R FLEXIBLE COUPLINGS

When you have a flexible coupling problem, or are considering couplings for direct connected machines —remember this name— *L-R Flexible Couplings* —because it means greater profits for you through lower operating costs and higher efficiency of power utilization.

L-R Flexible Couplings require no lubrication and are designed for the most efficient application of space, speed, power, and operating conditions—in fact there is an L-R Coupling for every flexible coupling requirement. You undoubtedly will find one of the standard units exactly suited to your requirements. Sizes range from $\frac{3}{16}$" to 14" bores, for the smallest pump to giant steel mill rollers.



Get complete information by asking for catalog, and make this triple combination work for your interests!

LOVEJOY FLEXIBLE COUPLING CO.
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housing may carry sufficient heat away by conduction to increase ratings.

It can be seen, however, that additional external fans for ventilation across the stator, with provision for rotor heat transfer, is essential in most cases. The amount of cooling air upon which the rating is based can be obtained from the manufacturer together with approval or criticism of the ventilating scheme proposed.

MOUNTINGS: A uniform air gap makes for uniform torque, good characteristics and a quiet motor. Concentricity and close tolerance from stator shell to stator bore and from rotor periphery to rotor bore are provided by the motor maker. The machine designer must keep the balance of this chain of fits within similar limits—at the shaft, rotor and also at the bearing, bearing housing, rabbet on the end shield, housing rabbet and housing bore.

All of these tolerances and fits should limit the air gap variation to not more than 10 per cent. Press fits are best, but removal of stator and rotor in the field is not easy with this arrangement. Shaft sizes also must be of sufficient strength to prevent deflection of rotor beyond the 10 per cent limit mentioned. Motor torque should also be considered in providing adequate mounting strength.

BALANCE: Regardless of how well a motor is balanced prior to mounting on the final shaft, unbalance may result from the fit, shaft or bearing eccentricity, load unbalance or criticals of the system, as well as other causes. Clamping a rotor on a shaft may introduce stresses and unbalance unless the clamping washer and rotor faceplate rabbet have a perfect fit. Final balance of the complete assembly must be anticipated, yet no material should be removed from the rotor end rings in accomplishing the balance.

LUBRICATION: Adequate lubrication and proper bearing selection is assumed. Machinery manufacturers generally have an extensive knowledge of this subject and have the co-operation of bearing manufacturers. Provision on the motor should be made for adequate cleaning and flushing of the bearings. Care should be taken that no oil or grease enters the motor where it might harm the windings. While good insulations are resistant to moderate amounts of oil, needless exposure will only increase the possibility of shorter motor life .

ACCESSIBILITY: Provision should be made so that the motor can be easily dismantled in case of emergency and also so that the bearings can be properly lubricated. There are, of course, many other engineering considerations but these are major ones.

Thus it is apparent that the decision of whether or not to use shell-type motors should be carefully considered. Many compromises exist between shell-type and standard foot-mounted motors which might be exactly suitable for a given application. Some of them include flange-mounted, face-mounted and partial motors of all types.

Low Cost made possible by improved designs, large quantity production and production methods . . . Dependability developed thru hundreds of different applications in the field . . . Stamina built-in for continuous operation and . . . . . High torque developed thru integral back gearing . . . . Cased or skeleton types with standard gears that give "any" speed, that save engineering, cost, and space of requirements of auxiliary speed reducing means . . . . Single drives, double drives—from top, bottom, right or left. Miniature motors for a hundred uses; motors that make *automatic* tuning, *automatic* opening and closing, automatic features that make sales at incidental costs.

Sold singly, in dozens, thousands or millions.

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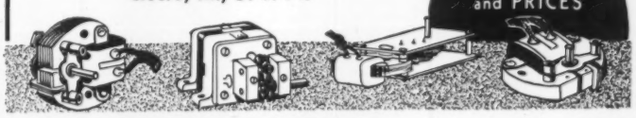


A reproduction of Model AG—6H.P. Engine with clutch and power take-off.

10 sizes—1 to 30 H.P.

STURDY, POWERFUL UNITS DESIGNED FOR HARD SERVICE

Still they weigh less — they take up less space and they cost less. Ask for complete catalog.

HEAVY DUTY AIR COOLED ENGINES by WISCONSIN MOTOR CORPORATION

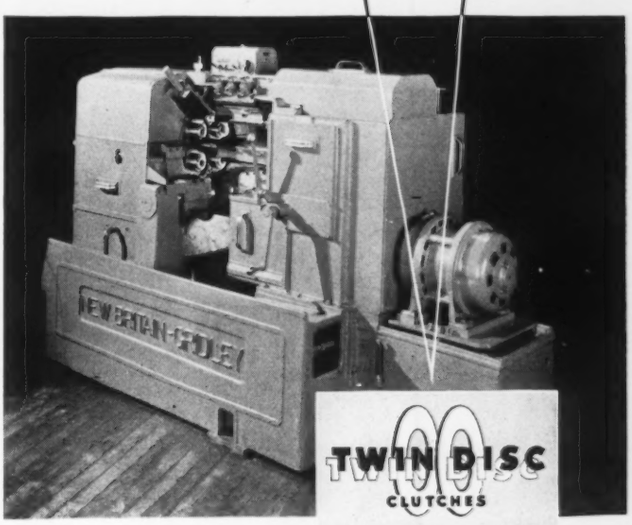
WISCONSIN
MOTOR CORP., MILWAUKEE, WIS.

No Spindle Lag!

● When the Twin Disc Clutch which drives the spindles on this multiple screw machine is released, the spindles stop almost instantly instead of slowly coming to rest.

When the clutch is "thrown out," the multiple driving and driven plates of the clutch separate immediately by an appreciable distance. There is no continued slight contact. As a result the spindles come to rest with minimum lag.

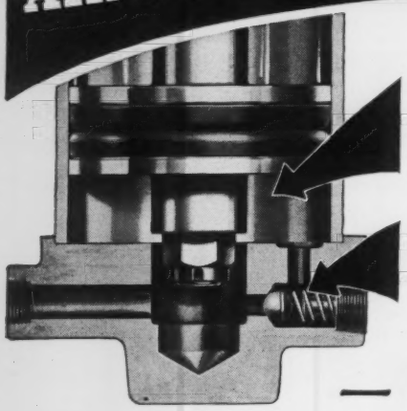
This immediate response of the spindles saves time—makes the screw machine a better producer for the user—a better seller for the manufacturer. Write for recommendations. Twin Disc Clutch Company, 1325 Racine Street, Racine, Wisconsin.



New Britain multiple spindle-screw machine equipped with 2 Model CC Twin Disc Clutches.

TWIN DISC CLUTCH CO. • 1325 RACINE ST. • RACINE, WIS.

NOW WRITE *Cushioned* IN ALL AIR CYLINDER "SPECS"



New Non-Adjustable Air Cushion by NOPAK eliminates need for non-cushioned cylinders.

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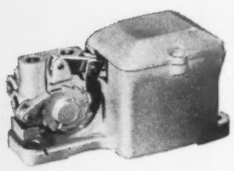
Quick-Opening Air Duct assures swift, smooth cylinder action on every stroke.

— Give Your Machines New Smoothness

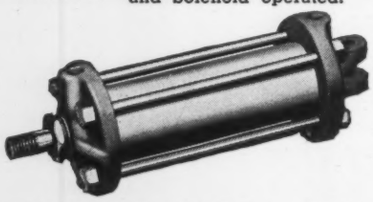
Instead of specifying "cushioned" or "non-cushioned" cylinders, simply specify NOPAK Cushioned Air Cylinders in one of these types:

- New type NOPAK Cushioned Air Cylinders with *Non-Adjustable* Cushion-Heads. They eliminate the noisy, damaging metal-to-metal impact of non-cushioned cylinders . . . yet sell in the *same* price range.
- Standard type cushioned air cylinders with *adjustable* Cushion-Heads . . . where close regulation of "cushion effect" at end of piston stroke is required.

Either type assures smooth, efficient, trouble-free performance of air powered equipment, prolonged life for pistons and cup-leathers, lower maintenance cost for the entire cylinder assembly. Both types have Special Composition Cup Packing and extra-wide piston bearing to protect cups from excessive wear and friction. Write for bulletin.



For positive control, specify famous patented NOPAK Air Operating Valves . . . Lever, Foot and Solenoid operated.



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NOPAK VALVES and CYLINDERS

A 2490-½

Hydraulics Cannot Be Denied!

(*Concluded from Page* 31-*S*)

and out" slide provides the component perpendicular to the right and left movement.

In the vertical plane method of tracing each contour is scanned by the use of the vertical slide and the table. By merely turning a handle the machine can be changed from one method to the other.

As *Fig.* 7 indicates, the cutter and tracer are integrally mounted on one rigid member. Thus the cutter is compelled to describe the same relative path with respect to the workpiece as the tracer describes with respect to the master. The remaining requirement for duplication is that the cutter be the exact size and shape of the tracer. Force exerted between the tracer and the master is extremely small. It is possible to interpose one's finger between the tracer and master without the slightest danger of injury.

These examples of milling machines, their circuits and operations are taken from patents by the Cincinnati Milling Machine Co., and are merely illustrative of the flexibility which can be obtained by the use of hydraulics. Hydraulic-electric combinations also have been used with success for complex cyclic operations on milling machines and other machine tools.

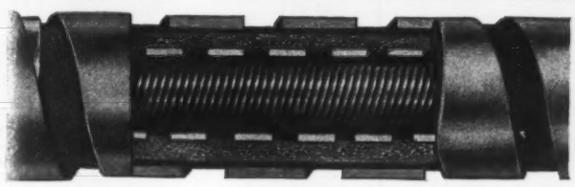
The modern design engineer can no longer ignore the challenge of hydraulics. Its manifest advantages are now established facts where once they were questionable theories.

Attaining Speed, Power, Flexibility

(*Concluded from Page* 23-*S*)

An instrument panel is mounted on the front of the machine, as can be seen in *Fig.* 1. This contains three oil gages which register lubricating pressure in both the jet and force-feed systems. Provision is made in the panel for mounting a tachometer which registers work speed.

The design job in this machine is notable because of the comprehensive way in which desirable characteristics, gathered from comments by operating men, were organized and then painstakingly sought in the design. Although an industrial stylist was engaged to modernize the exterior, no streamlined features were added unless they served actual functional purposes. The result is a versatile, sturdy, good-looking machine with distinctly modern design features.



Special rubber case for resistance to stretch under high tensile strain, extreme temperatures, moisture and tropical sunlight. One of several Stow cases.

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Inventor Of Flexible Shafting—1875

For 64 years Stow engineers have overcome difficult power drive and remote control problems in all industries. Where power transmission or control is necessary between units, regardless of relative position, and where freedom to move independently is required, flexible shafting is dependable.

ENGINEERING SERVICE

Stow engineers will assist you in working out power drive and remote control problems, without obligation. Simply send the necessary data.

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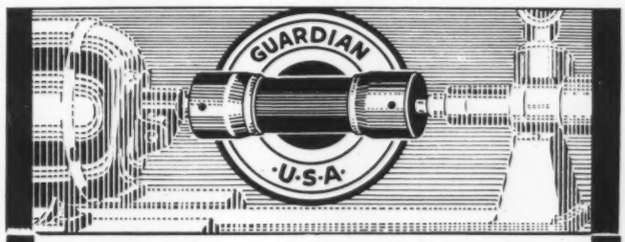


A Custom-made Coupling

that means

QUIET OPERATION-FLEXIBILITY LONG LIFE *plus* LOW COST

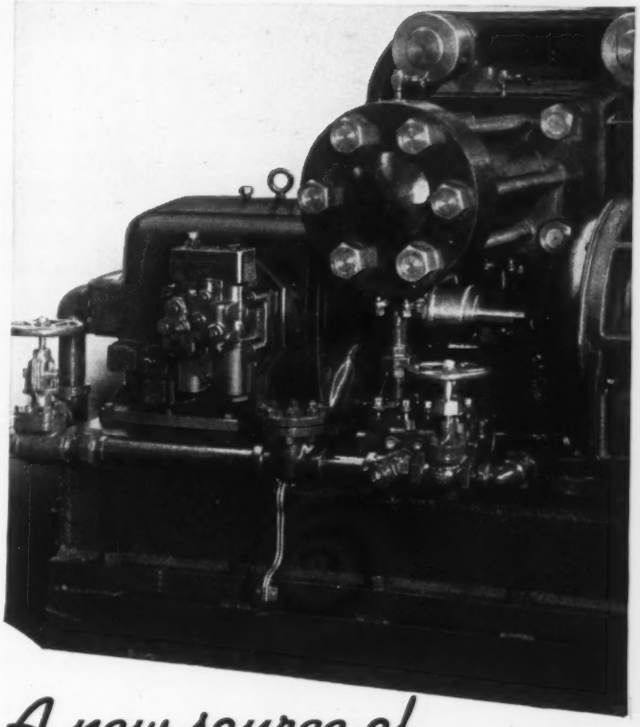
Here is a direct-drive coupling of proven advantages in scores of uses — Oil Burners, Refrigerators, Circulators, Pumps, Washing Machines, and Ironers — in fact, on almost every type of equipment where cushioned power is important. Guardian Flexible Couplings are used. Tailored to YOUR job, in any combination of bores from $\frac{5}{16}$" to $\frac{5}{8}$", and in lengths from 2" up ($\frac{3}{8}$" bore, from 2½" up). GUARDIAN might better YOUR product—and improve your sales! Write for sample today.

GUARDIAN UTILITIES CO.

MICHIGAN & PINE STREETS, MICHIGAN CITY, IND.

GUARDIAN FLEXIBLE COUPLINGS

Oilgear Fluid Power



A new source of design progress for you

When Sales clamor for something different . . . better; when conventional avenues of approach are exhausted . . . turn to OILGEAR Fluid Power Transmissions. It opens a fertile field of design progress probably untouched by you.

OILGEAR Fluid Power transforms energy from any constant speed source into rotating or reciprocating motion of steplessly variable speed, forward or reverse. The heart of OILGEAR, the efficient OILGEAR pumping mechanism, transforms mechanical power into an oil flow, in turn converted into controllable rotation in an OILGEAR oil-motor or into controllable reciprocating motion in an OILGEAR cylinder. The medium of transmission, oil, results in cushioned power, simple yet positive control, self-lubrication, high efficiency and negligible maintenance.

To the extent our confidential role permits us, we'll be glad to check the experiences of great manufacturing companies with you. In many cases sales history is quietly, even secretly being made with the use of OILGEAR Fluid Power . . . one of the most applicable and valuable tools of advance for the designer. THE OILGEAR COMPANY, 1321 W. Bruce St., Milwaukee, Wis.

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DESIGN
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Through the centuries design has pressed forward. Often hated, frequently fought, design progress cannot be stopped.

Today the tempo has quickened. The parade doesn't wait for laggards!

This parade is pictured in the pages of MACHINE DESIGN. Every article is a record of progress from which the design engineer can adapt ideas to his own problems.

From the more than 7500 manufacturers of machines, from the thousands of makers of parts, materials and process equipment, from practicing engineers and the laboratory, the latest developments are brought to your attention.

Watch for these developments!

Looking Ahead!

(*Continued from Page* 35)

braking, etc., are finding their way into many designs. They preclude the use of expensive mechanical reverse mechanism, load and fire arrangements, friction driving mechanism, and the like.

Multimotor and built-in motor construction are in the ascendancy and along with this, built-in controls are bound to parallel. The built-in motors and controls go far toward avoiding what has been rightly called "tin-can design."

Great progress is being made in the co-ordination of the efforts of the engineering forces of both electric motor and control manufacturers, and machine builders. We see considerable evidence of more pleasing lines on motors and because of this many motors that have been so carefully put out of sight will find their way to the outside of the machine, making the design much more practicable.

At Brown & Sharpe we have studied this new trend and have developed several new machines with full electric drives and controls, and others that are a combination of mechanical-electric or hydraulic-electric. Many of these new designs have made use of multimotor construction, using anywhere from three to seven motors. With this type of construction, it has been surprising how easily various combinations of cycles have been obtained by electrical interlocking.

One of the big problems today in electrically-driven machines is preparing them for stock. This problem is caused by the many varieties of voltages and cycles used in this country and abroad. To relieve this condition motor manufacturers have developed what is called the "dual voltage and dual frequency motor," which to my mind should be extended if possible. Control manufacturers could help materially if they would follow this development and furnish controls with dual rating. If this is impossible, at least they could design so that changeovers could be made with a minimum amount of dismantling.

In spite of this problem I am certain that we will see many new machines in the future, designed completely around these natural electric functions.

"... more precise control required."

W. C. SUTTON, Chief Engineer
The Lindsay Wire Weaving Co.

KEYWORD in present machine design is more precise control as now required in the manufacture of nearly all products. These requirements include control of speeds, pressures, movements and time intervals.

Fluid pressure mechanisms are being more widely used, especially in metal forming and cutting machines. Flexibility of control is an important factor,

IDEAL "Select-O-Speed" TRANSMISSION

Use Standard V-Belts

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Sizes up to 7½ H.P.

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Inexpensive

This Variable Speed Transmission can be included in the design of new equipment at little additional cost. Low price and compact size make the *Ideal* "Select-O-Speed" practical for thousands of uses where high cost installations have previously made it impossible to use variable speed transmissions.

Operation is extremely simple—a mere movement of the control lever gives infinite selection of speeds over a wide range—instantly, while in operation.

The "Select-O-Speed" is indispensable wherever variable speeds are necessary or desirable. Is as easy to install as ordinary V-belt drive. Unique design permits use of standard V-belts.

Write for complete information

TRANSMISSION DIVISION

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TRU·LAY

PUSH-PULL CONTROLS

Positive—Smooth—Accurate

Incorporate **Perfect Control** into designs for Remote Control of countless varieties of mechanisms.

Tru-Lay Controls make possible the transfer of motion from stationary to moving points or mechanisms. Positively, smoothly and accurately.

These units can be snaked around obstructions, doing away with toggles, bellcranks, rods, pins, etc., which wear with use, becoming noisy and requiring constant adjustments and replacement.

Write for the descriptive folder, "The Key to Remote Control."

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In Business for Your Safety

For "Close Quarters" Use The Sturdy, High Capacity MICRO SWITCH

LK LIMIT SWITCH

1—Movement Differential 0.001" or less.

2—Pretravel of actuator plunger to operating point, 0.010".

3—Overtravel of actuator plunger beyond operating point 1/32".

4—Distance between operating point and C. L. of 1/16" dowel pin holes held to ±.003".

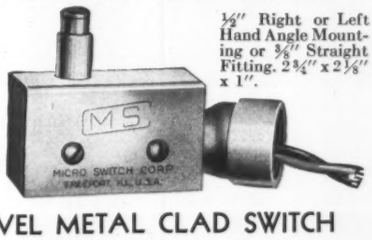
1/4" OVERTRAVEL METAL CLAD SWITCH

1—Movement differential under .0005".

2—Operating pressure about 8½ oz.

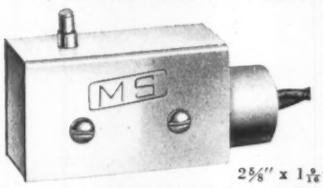
3—Overtravel of actuator plunger beyond operating point 1/64".

4—Heater loads 1200 watts up to 600 volts A.C. Also inductive loads, solenoids, and relays, ½ H.P. up to 460 volts A.C. Same on all three switches shown here.



½" Right or Left Hand Angle Mounting or ⅜" Straight Fitting. 2¾" x 2⅛" x 1".

1/16" OVERTRAVEL METAL CLAD SWITCH



2⅝" x 1 9/16" x 1 7/32"

1—Operates on 0.001" movement, 14 oz. pressure.

2—Can be used in any position—vibration-resistant.

3—60 or more snaps per minute. Millions of operations. Cut your costs and speed up production with these rugged, sure-acting MICRO SWITCHES.

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Write for specification sheet and recommendations covering *Micro Switch* applications. Samples supplied for trial tests.

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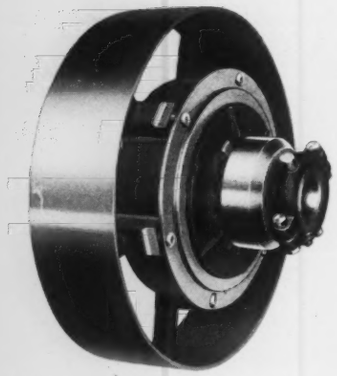
CONWAY CLUTCHES

are Control Commanders



The Conway Disc Clutch (patented U. S. A. and Canada), whether mounted on pulley, sprocket, gear, or sheave . . . is attractive . . . is safe . . . is enduring . . . is enclosed . . . is powerful . . . is adjustable . . . is simplicity itself.

Besides, it functions satisfactorily. Its large lever ratio, underslung actuators (forgings), interchangeable parts, centripetal action, and large frictional area, bring about its easy engagement, instant release and dragfree idling.

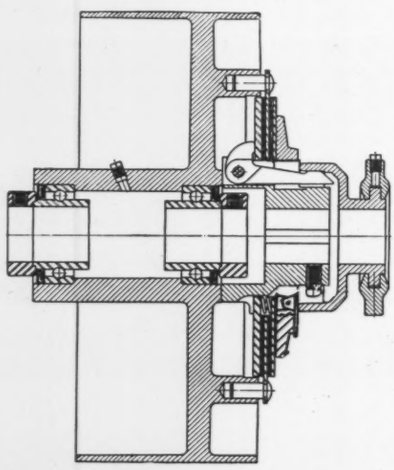
Yet the Splendid Disc Clutch is but one of the many kinds of Clutches, which Conway offers to the entire requirement of power transmission service: Compression and Expansion Clutches, One Revolution mechanisms, Overload Release frictions, and special units for special drives, in sizes from 1/2 to 300 H. P., in speeds up to 2300 R.P.M. is a complete answer indeed to the demand for prime movers.

The Conway Clutch Company, established 1904, has learned a thing or two about starting and stopping machinery:

And it has embodied it all . . . knowledge and experience . . . into its fine products, **CONWAY CLUTCHES.**

Write for literature: P-24; L-28; XYZ-L; K-32; E-8; No. 36.

The Conway Clutch is a luxury of performance without which a good machine is handicapped.



THE CONWAY CLUTCH CO.

1546 Queen City Avenue
CINCINNATI, OHIO

in addition to the enormous increases available in mechanical advantage. Hydraulic-type variable speed transmissions offer smooth acceleration and deceleration, ready reversal, and a fine control of torque output. The mechanical infinitely variable drive also has many advantages in precise control of machine functions.

Control of movement or position, as distinguished from speed, makes possible automatic operation of machines as well as more precise manual operation. We may expect to see still further improvements in construction, visibility and ease of operation of all types of machine controls. The larger feed dials, micrometer stops, electric remote controls, centralized control stations and built-in control units now provided are a sure indication of developments to come.

Mechanisms for the control of time intervals are now available to the designer in greater variety than ever before. At one extreme we find split second control of welding operations achieved by electronic devices, at the other we have synchronous motor and clock mechanisms to regulate longer periods. Timing is also a function of the variable speed devices already mentioned.

" . . . . magnetic clutch operates drive."

A. W. MILLS & F. J. FURMAN, Engineering Laboratory
International Business Machines Corp.

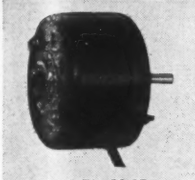
A CLUTCH designed for a two-speed drive from a constant speed motor in our alphabetic bookkeeping and accounting machine had to give a fully automatic and noiseless change from one speed to the other, with as smooth a pickup as possible. In the drive as developed, the motor turning at 2000 revolutions per minute drives two speed pulleys through V-belts. The high speed pulley is driven at 1500 revolutions per minute, the low speed at 800. These pulleys are the driving means of the clutch that transmits the power to machine through a 10 to 1 worm reducer.

Between the drive pulleys is the clutch disk, rigidly fixed to the worm shaft. Centrally located in the clutch disk are three steel balls, 1/32-inch larger in diameter than the overall thickness of the disk and the clutch facings. These balls are used to disengage positively the pulley that is driving before the other pulley can be engaged.

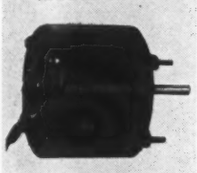
Engagement or operation of the clutch comes through the energization of either high speed or low speed magnets when a change in control in the machine occurs. Energization of either of these magnets attracts a two-speed clutch armature that is pivotally mounted with the clutch engaging lever. The drive pulley selected is forced into contact facing on the clutch disk with a pressure of approximately 60 pounds, thereby driving the machine proper.

When the machine is idling the two speed pulleys remain in a neutral position while the clutch disk re-

VICTOR
Super-Power MOTORS



MODEL M41



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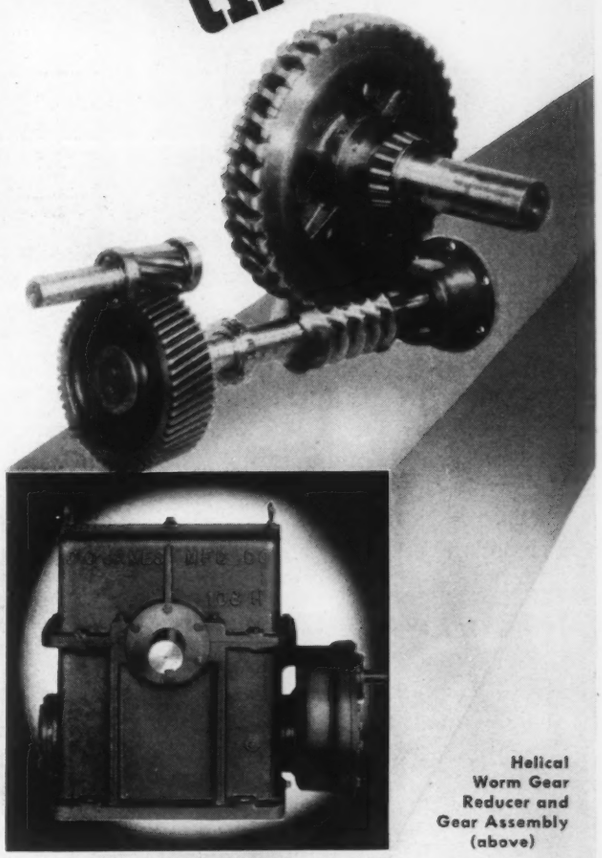

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CATALOG M-59

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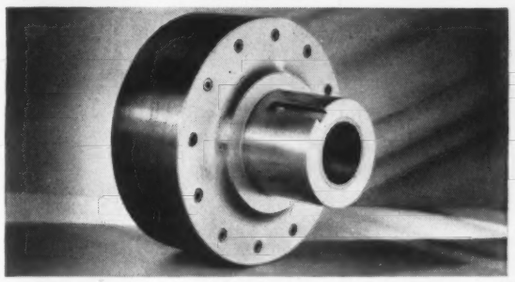

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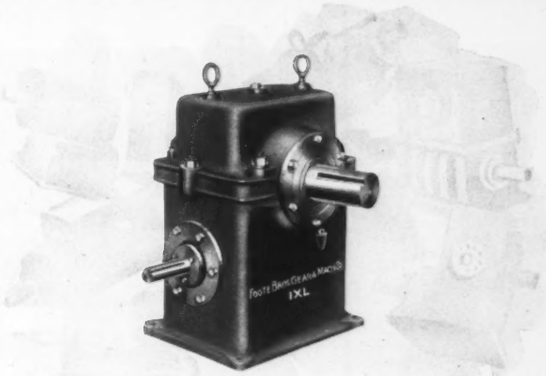

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These pages represent the third edition of the "Machine Drives and Controls" Supplement. Presented as an integral part of the April, 1939, issue of MACHINE DESIGN, it is written and compiled for design executives in the machinery manufacturing field, for the express purpose of bringing together factual information that will aid them in their daily problems.

To serve readers most effectively the Supplement has been stitched separately as a composite unit, and then stapled into the center of the magazine so that it can be taken out by removing two staples without injury to the insert or to the magazine proper. This permits filing by subject to provide ready reference.

With the editorial contents written and edited to assist designers of machinery in selecting the best possible drives or controls for their conditions, the Supplement will find immediate acceptance and use. The advertising section constitutes a veritable "Where-To-Buy" Directory.

Like MACHINE DESIGN'S previously-published Directories of Materials and Special Supplements covering specific phases of design, this special section adds another valuable reference work to the engineer's library.

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Covers every size and type of machinery--- from the "Wristwatch to the Locomotive"

MACHINE DRIVES AND CONTROLS SUPPLEMENT

APRIL 1939

CONTENTS

	Page
Attaining Speed, Power, Flexibility *By George Z. Griswold*	21-S
When to Use the Shell-Type Motor *By O. F. Vea*	24-S
Hydraulics Cannot Be Denied!—Part I *By Hans Ernst and Albert H. Dall*	28-S
To Help Machine Sell—Use Quiet Drive *By John W. Greve*	32-S
Looking Ahead!	35-S
Design Features in New Machines	36-S
Electronics Make Difficult Processes Simple	38-S
Nonmetallic Gears and Couplings Deaden Vibration	48-S

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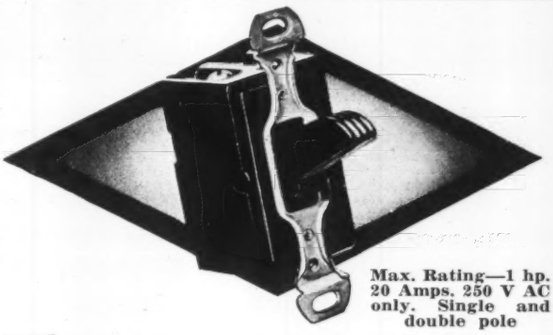

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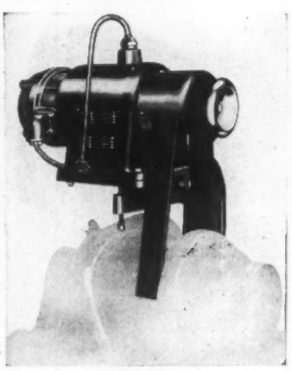

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Convenience and safety to the operator are assured in the shielded drive, the hand wheel for set-up work, and the conveniently placed lever for speed changes.

Mounting brackets available for lathes, milling machines, shapers and punch presses.

Every means of completely modernizing machine tools in a safe, economical way are present in the design and construction of the Lima Electric Gearshift Motor.

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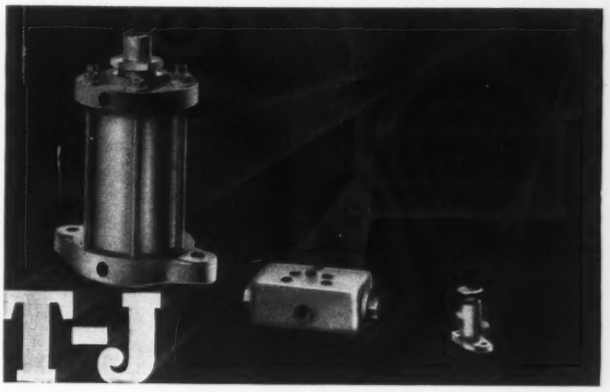

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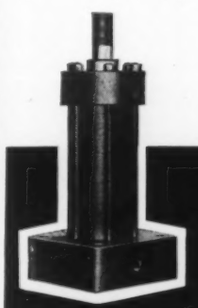

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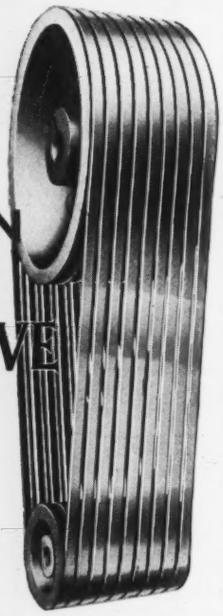

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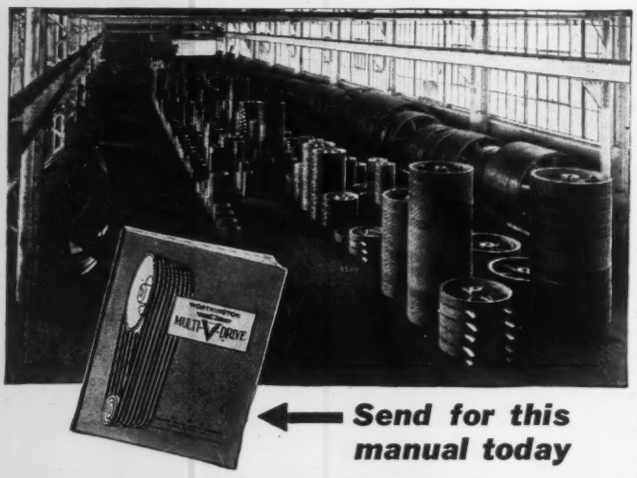

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April 1939

INDEX TO ADVERTISERS

Allen-Bradley Co. 53-S, 54-S
American Cable Division, American Chain & Cable Co., Inc. 65-S
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American Engineering Co. 43-S

Baldwin-Duckworth Chain Corp. 47-S
Bodine Electric Co. 56-S
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Dayton Rubber Mfg. Co., The 74-S
De Laval Steam Turbine Co. 57-S
Dumore Co. 17-S

Farval Corp., The 9-S
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Gear Specialties, Inc. 70-S
General Electric Co. 5-S, 6-S, 7-S, 8-S
General Radio Co. 55-S
Guardian Electric Co. 58-S
Guardian Utilities Co. 63-S

Hanna Engineering Works 3-S
Hannifin Mfg. Co. 40-S
Hart Manufacturing Co., The 71-S
Hilliard Corp., The 69-S

Ideal Commutator Dresser Co. 65-S

James, D. O., Mfg. Co. 67-S
Jones, W. A., Foundry & Machine Co. 42-S

Lewellen Mfg. Co. 44-S
Lima Armature Works, Inc., The 71-S
Link-Belt Co. 39-S, 41-S
Logansport Machine, Inc. 20-S
Lovejoy Flexible Coupling Co. 60-S

Michigan Tool Co. 45-S
Micro Switch Corp. 65-S
Monitor Controller Co. 16-S
Morse Chain Co. 18-S

Ohio Gear Co., The 46-S
Oilgear Co., The 63-S

Peerless Electric Co., The 48-S
Philadelphia Gear Works 59-S

Racine Tool & Machine Co. 52-S
Reeves Pulley Co. 12-S, 13-S
Rockford Drilling Machine Division of Borg-Warner Corp. 49-S

Speedway Manufacturing Co. 61-S
Stow Manufacturing Co., Inc. 63-S
Sundstrand Pump Division, Sundstrand Machine Tool Co. 73-S

Tomkins-Johnson Co., The 71-S
Twin Disc Clutch Co. 61-S

Victor Electric Products, Inc. 67-S

Wagner Electric Corp. 10-S
Waldron, John, Corp. 67-S
Westinghouse Electric & Mfg. Co. 14-S, 15-S
Whitney Chain & Mfg. Co., The 2-S
Wisconsin Motor Corp. 61-S
Worthington Pump & Machinery Corp. 72-S

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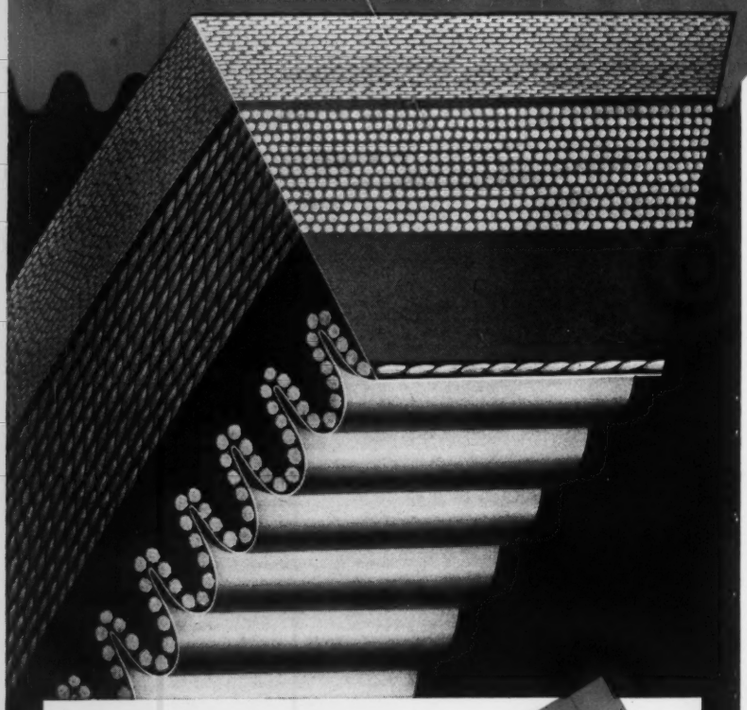


Developed as a result of 7 tireless years of tests and research by Dayton's famed technical laboratories, Super-Flex Dayton Cog-Belts with Daytex Cord in their neutral axis section reduce maintenance expense to a minimum never before achieved.

Daytex Cord, steel-like in strength, is made from highest grade long-staple, hard-bodied cotton. In the process of manufacturing, a bonding-compacting agent removes the non-essential oils and waxes from the individual fibres. This causes the fibres to interlock and form a stronger, yet more compact cord.

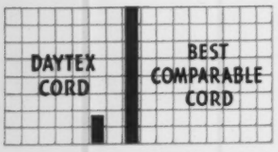
Due to Daytex Processing—Daytex Cord becomes on an average 22% smaller in diameter. It improves in tensile strength, runs cooler, stands up under constant high-speed flexing. Furthermore, it has lower stretch and, due to interlocked fibres, has minimum tendency to become lifeless.

This denser Daytex cord is cooler running because highly developed rubber compounds are forced into and around each individual cord by Dayton's patented Latexing and Calender Process. These processes have been pioneered, and constantly improved by Dayton for 19 years.

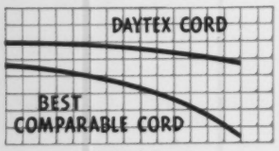
Outstanding in basic design, Super-Flex Dayton V-Belts are built to bend with patented cog construction. They work on short centers—save space—assure you longer life—and reduce adjustments to a negligible minimum. So to step-up *your* production standards—to lower your costs, demand Super-Flex Dayton V-Belts made with Daytex Cord.

THE DAYTON RUBBER MFG. CO., DAYTON, O.

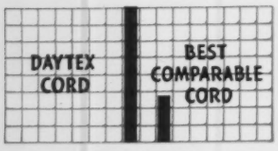
The charts below show results of laboratory tests of Daytex Processed cord versus best comparable cord NOT Daytex Processed.



LESS STRETCH
Stretch test-cords.

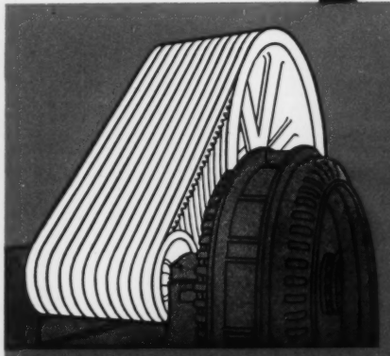


STRONGER
Tensile test-cords.



LONGER LIFE
Belt flexing test.

LABORATORY TESTS PROVE THE OUTSTANDING SUPERIORITY OF DAYTEX CORD

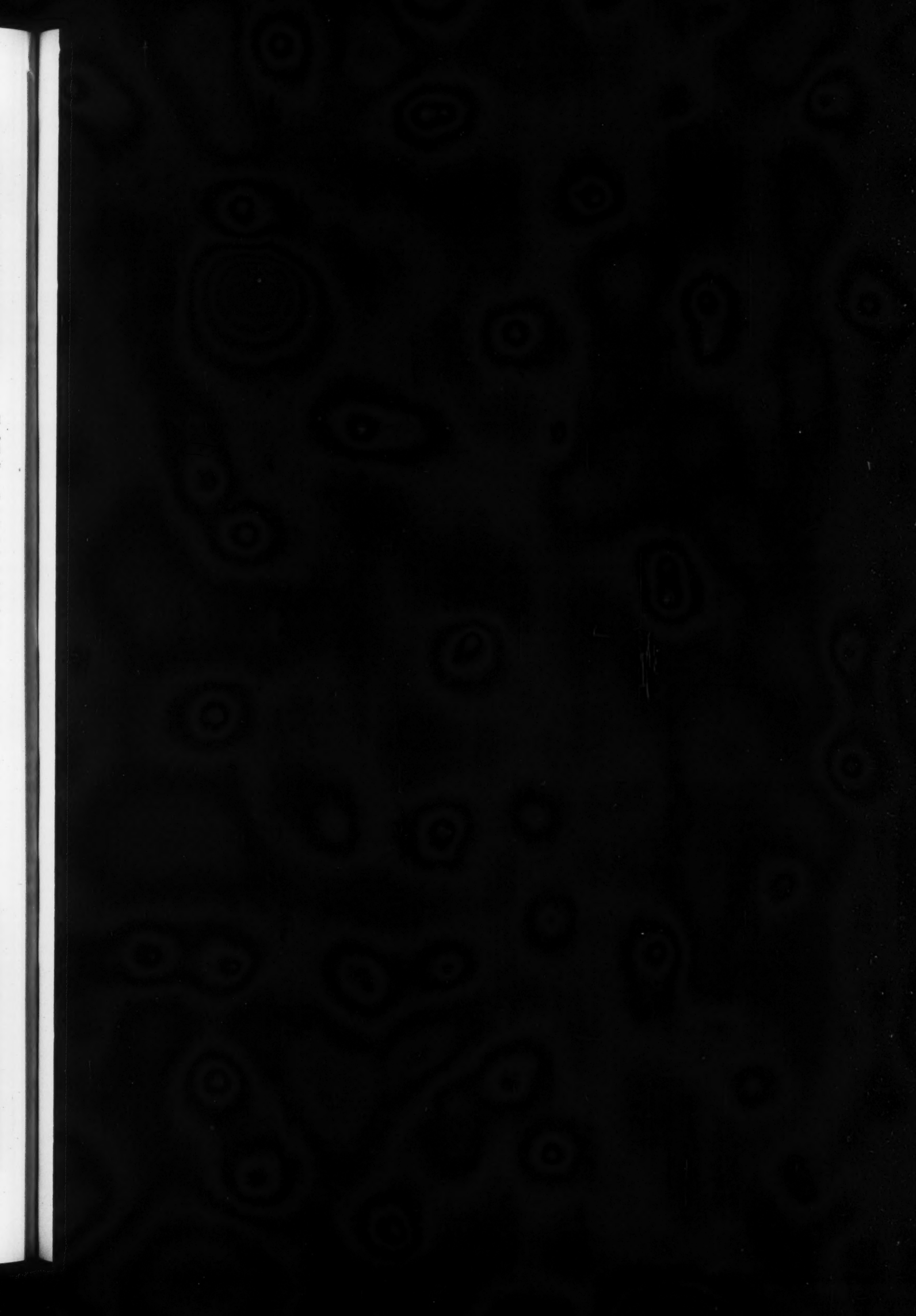


Super-Flex

Dayton

COG-BELT DRIVES WITH DAYTEX CORD

MADE BY THE WORLD'S LARGEST MANUFACTURER OF V-BELTS



It's Time To Broadcast Facts Regarding Use of Machines

COMMENDATIONS are due the American Society of Tool Engineers for establishing a fact finding committee to study the "effect of the development of the machine on employment and the standard of living." In view of the widespread misunderstanding on the part of the general public on this subject, and because of the increasing necessity for improved relations and confidence between the government, manufacturers, employes and consumers, "fact finding" cannot be too strongly urged.

Initial investigations of the committee, as reported at the recent annual meeting of the society, confirms the belief among engineers that the machine aids rather than retards employment. The committee has done excellent work in correlating and analyzing available data, and it is to be hoped that its further efforts will bring to light many original and outstanding examples of the benefits of the machine.

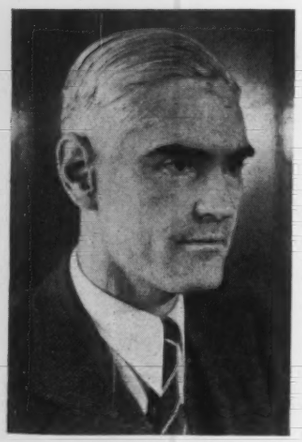
Effectiveness of such findings, it seems, will be partially lost unless the information gathered is presented in the proper quarters and in the right way. It would be expecting too much to anticipate that any single body such as the A. S. T. E. could sponsor not only a fact finding committee but also an intensive campaign to present the results to the public at large. But that such action is essential is evident. This may be recognized by other engineering societies, associations of manufacturers and similar large bodies to the end that co-operative steps will be taken not only to uncover the facts but to broadcast them effectively. Newspapers, "popular" magazines and even movie films might well be enlisted to serve as mediums for the dissemination of pertinent news regarding the machinery industry.

Two things can be done by engineers in the meantime. One is to give all possible assistance to the A. S. T. E. fact finding committee; the other—to take the opportunity of pointing out the advantages of the machine on every logical occasion.

Machine Drives and Controls

DRIVES and controls being common to all types of machines, MACHINE DESIGN takes pleasure in presenting in the current issue its third annual supplement on this important subject. Present practice, trends and future possibilities alike are given attention. The supplement is, as usual, bound separately and stitched as a unit into the center of magazine proper. It can be removed readily for filing, is desired, by taking out the two connecting staples.

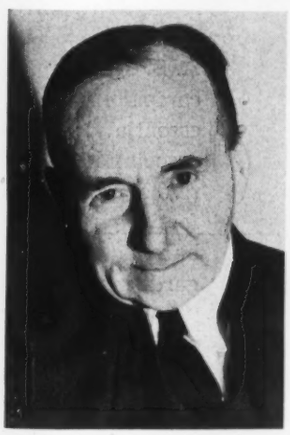
Men of Machines



J. Carlton Ward

DEVOTING the major part of his career to building of precision machines typical of those used in construction of modern aircraft engines, and recently to building engines, J. Carlton Ward Jr., has been appointed vice president and director, United Aircraft Corp., and general manager, Pratt & Whitney Aircraft division.

Graduating from Cornell, Mr. Ward spent two years in research engineering. In 1916 he joined Niles-Bement-Pond as mechanical engineer. After serving in the war, he returned to this company's Pratt & Whitney division. Here he was active in the production of the first Wasp engine on machine tools he had helped develop. He left to join Hartford Machine Screw Co. as vice president and general manager, and in 1935, after five years with General Cable Co., he again returned to Pratt & Whitney engine division as assistant general manager.



Marion A. Savage

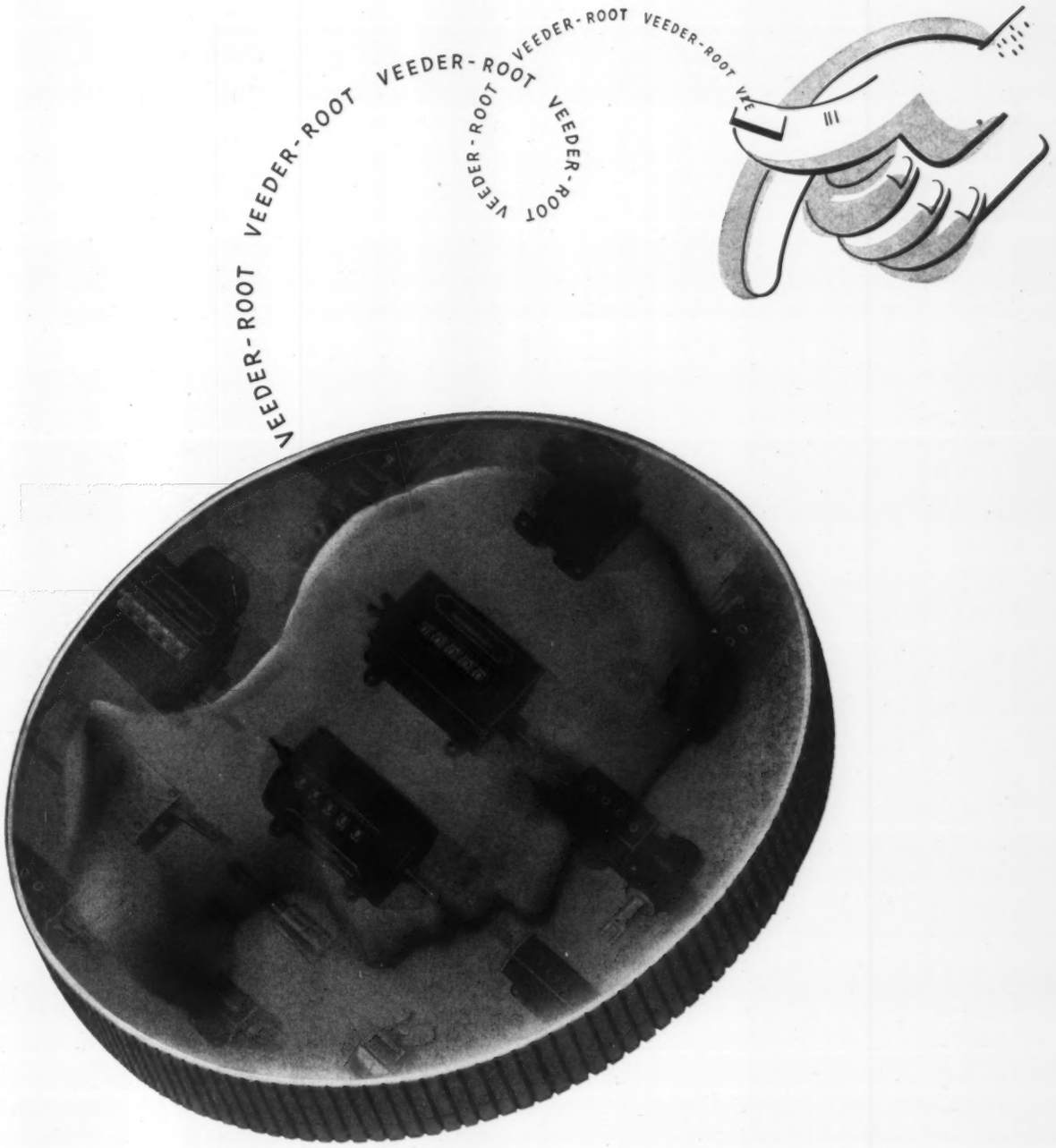
AWARD of the Lamme Medal of American Institute of Electrical Engineers brings recognition to Marion A. Savage, designing engineer, General Electric Co. "for able and original work in development and improvement of mechanical construction and efficiency of large high-speed turbine alternators."

After graduating, Mr. Savage obtained experience as student engineer in eleven departments of General Electric, and in 1909 was transferred to turbine-generator section, alternating-current engineering department. He was placed in charge of this section in 1923 and became design engineer eight years later. Mr. Savage also received the Coffin award in 1932 for outstanding engineering ability in design and development of large steam-driven generators. Recently he has directed development and engineering associated with large turbine generators cooled by hydrogen.

Edward A. Johnston

FROM the time he received his first farm implement patent until the present, Edward A. Johnston, recently retired vice president in charge of engineering and patents of International Harvester Co., has exerted considerable influence on the design and construction of farm machines.

At the early age of fourteen Mr. Johnston joined Johnston Harvester Co. Five years later he became associated with McCormick Harvesting Machine Co. where in 1897, at the age of twenty-two, he was granted his first farm implement patent. While there he designed and built an automobile, and won a first prize with an auto-mower. Leaving the McCormick company he was connected for a time with Keystone Co. He then joined Harvester Co. and directed the designing and building of the company's first auto-buggy, predecessor of its line of motor trucks, and the company's first



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Thermal Stress Article Is Amplified

To the Editor:

IN SPITE of the time and attention devoted by engineers to the study of failures there is a disproportionately small showing in technical literature. Mr. Shepherd's article ("Why Thermal Stresses Cause Failure of Parts," M.D., Feb., p. 41) on this score alone is welcome. Moreover, it deals with a common but imperfectly understood type of failure. Having had experience with the phenomena involved, we are contributing some amplifying remarks.

A word might be said first about the conditions under which thermal stresses are possible. If a body is subjected to a certain temperature distribution each part tends to expand proportionately to the local temperature. A study of the geometry of such deformation leads to the conclusion that if the temperature distribution is uniform or a linear function of the coordinates x, y, z, no stresses will result from the temperature distribution alone; any stresses which do exist will be those caused by external forces applied to the body. (Timoshenko, *Theory of Elasticity*, p. 203).

Loads Cause Plate Stresses

In the case of a plate having a linear distribution of temperature across its thickness, no stresses will exist in the plate unless the plate be loaded by external forces. Such forces might be those required to keep the plate flat. In that case the stress at the surface will be $\pm Ee\ \Delta T/2(1-\mu)$ where $\Delta\ T$ is the temperature drop through the plate, e the coefficient of expansion, E Young's modulus and μ Poisson's ratio. The term $(1-\mu)$ was omitted in the expression on Page 48 given by Mr. Shepherd.

For a radially symmetrical temperature distribution in a cylindrical shell, thermal stresses will exist even when no external forces are applied to the cylinder, as was pointed out by Mr. Shepherd. This is consistent with the criterion for the existence of thermal stresses given above, because if T is a function of r it depends on $x^2 + y^2$ and cannot be a linear function of the coordinates. The expression for the stress at the surface of a plate constrained to be flat, given in the foregoing paragraph, also applies to cylindrical shells if the wall thickness is very small compared to the radius.

Mr. Shepherd describes clearly how the tensile stress necessary to produce cracks at a surface develops from compressional deformation caused by a temperature gradient when the gradient dissipates. This is the mechanism by which cracks are formed in weld metal deposits, flame hardened steel surfaces and the brake drum failure cited. It should be recognized, however, that such stresses alone are inadequate to cause cracking in metal of substantial ductility and strength. Actually the tensile strength of the metal is usually seriously impaired by the surface heating when cracking occurs.

Grinding cracks in hardened steel originate also from thermal gradients, but the activating factor is quite different. In this case it is the contraction of the hardened metal with increase in tempering temperature that produces tensile stress in overheated areas. There is a release of heat on tempering that tends to maintain the reaction. That is why grinding cracks are so difficult to avoid in extremely hard steel such as is used for steel mill rolls.

—STEWART WAY
HOWARD SCOTT
Westinghouse Research Laboratories

Mr. Shepherd Replies

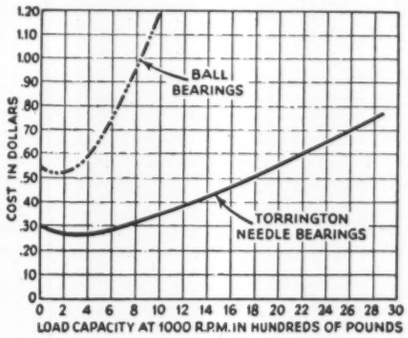
THE article on thermal stresses was offered as a typical exposition backed by pertinent studies of failed parts. It was believed that others might wish to discuss the subject further and for this reason the comments of Messrs. Way and Scott are distinctly welcome.

The application of Poisson's ratio is justifiable when the structure is simple and when the facts warrant the assumption brought into the calculation. However, exact conditions of heating and restraint are seldom known and often are too complicated to be understood or estimated accurately. This applies especially to diesel engine heads and cylinders. Diesel engineers so far as the author is informed use

(*Concluded on Page* 66)

SEE HOW LITTLE the TORRINGTON Needle Bearing Costs You

Note in the accompanying graph the low cost of the Torrington Needle Bearing, compared with ball bearings designed to carry the same radial load. See how little it will probably cost you to use this new bearing—and to get the advantages of anti-friction construction in your products.



And its low purchase price is only one of the economies you can effect by using the Torrington Needle Bearing. The bearing is made in a single compact unit, so that you can install it with a minimum of assembly time and expense. It can be quickly pressed into place on an ordinary arbor press—a method ideally adapted to the requirements of production line assembly.

You can often make other savings in the design of surrounding members. The shape of the bearing—its small diameter and long axis—allows you to use an extremely simple form of housing, with a consequent reduction in the amount of material needed.

High Load Capacity

The Needle Bearing has unusually high radial load capacity in proportion to its size, because its full complement of small diameter rollers provides many linear inches of bearing contact. It is suitable for severe service in either rotating or oscillating applications, and gives excellent results when used in high speed operation.

Lubrication of the Needle Bearing is efficient and thorough. The hardened retaining shell that forms the outer bearing race is provided with turned-in lips that hold plenty of grease or oil for long periods of operation. As the needles rotate, they constantly supply lubricant to the rotating shaft, insuring satisfactory lubrication with a minimum of maintenance attention.

Investigate the advantages of this low-cost anti-friction bearing in your own products. The Torrington Engineering Department will cooperate with you in laying out suitable applications for the Needle Bearing.

For further information, write for Catalog No. 9. For Needle Bearings to be used in heavier service, request Booklet No. 103X from our associate, Bantam Bearings Corporation, South Bend, Ind.

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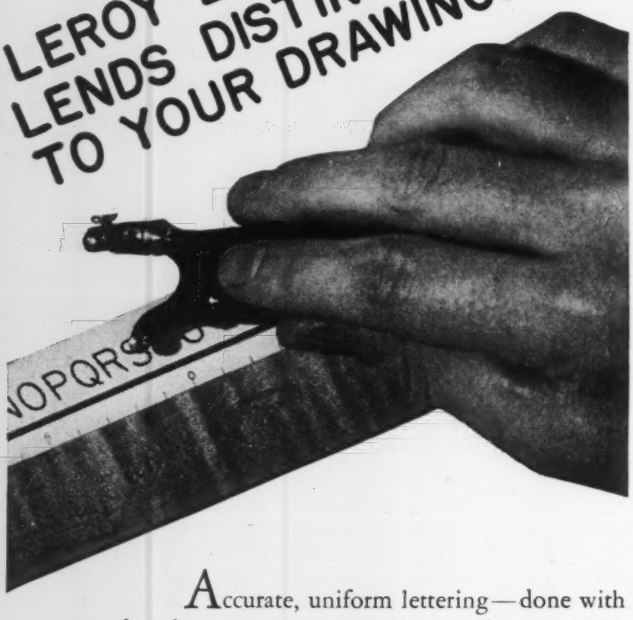

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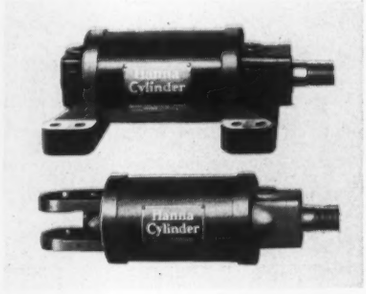
NEW Materials and Parts

(For Engineering Department Equipment see Page 56)

High Pressure Cylinders Introduced

A NEW line of high pressure cylinders, two models being illustrated, has been announced by Hanna Engineering Works, 1765 Elston avenue, Chicago. Designed for a maximum operating pressure of 1500 pounds, they are available in ten distinct types of mounting with diameters ranging from 1½ to 8 inches inclusive. Cylinders are centrifugally cast high test iron, machined to give a straight, concentric, mirror finish accurate to size. Cylinder heads and pistons are also iron. Heads and glands are secured by heat treated, alloy steel socket head capscrews. Pistons are fitted with "Step Seal" rings, piston rods being heat treated alloy steel, turned, ground and polished, and "chevron" packed. Differential piston rods, areas of which are one-half the cylinder area, are optional features. These cylinders all have cushions in both heads, preventing harmful metallic impact in the cylinder and shock in its mounting. Most important function is to prevent hydraulic shocks that "start" joints, burst tubes, ruin gages, etc. Ample air vent plugs are provided so that regardless of location of inlet ports there is always an air vent plug on the upper side of the cylinder head.

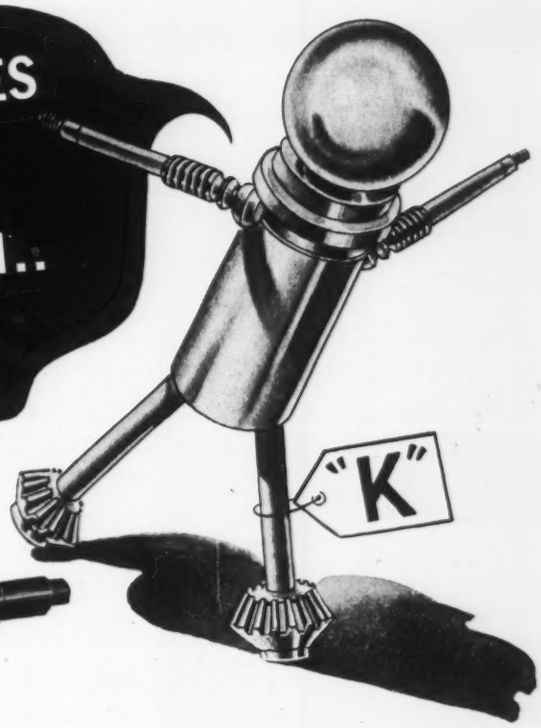


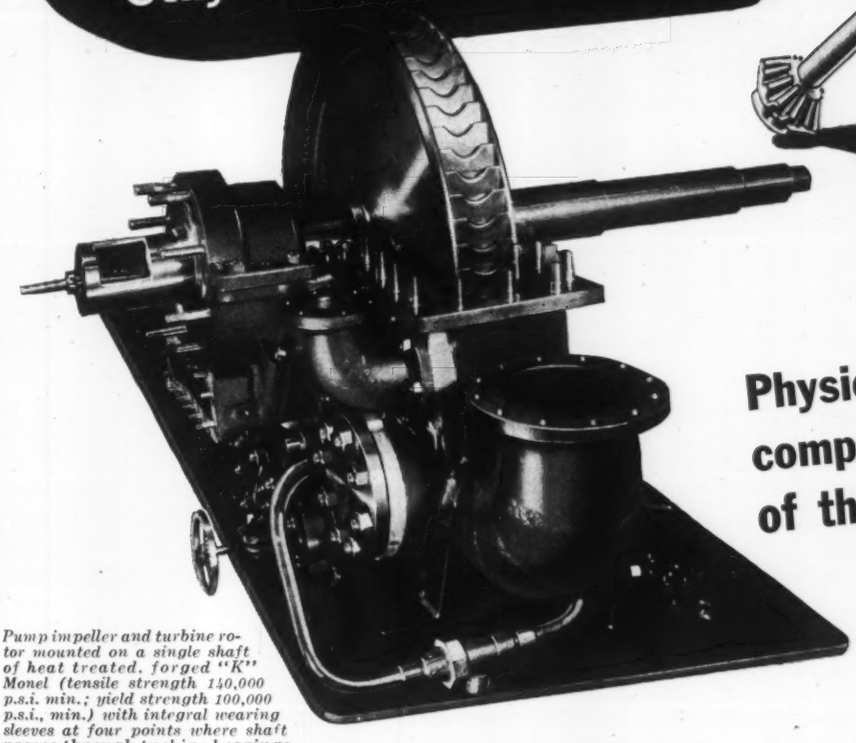
Designed for a maximum operating pressure of 1500 *pounds, new line of cylinders are centrifugally cast high test iron*

Coolant, Lubricant Pumps Developed

A NEW series of coolant and lubricant pumps has been announced by the Pioneer Engineering & Mfg. Co., 31 Melbourne avenue, Detroit. These units are designed to be used in conjunction with machine tools or auxiliary tanks where the unit must be driven with a belt, chain, gear or flexible coupling, or where it is impossible or impractical to mount motorized models. Model F-VB, illustrated, is built to mount on the side of a coolant or machine pedestal for close-

"For SHAFTS and SLEEVES I am the pick... I HAVE GREAT STRENGTH.. Stay Smooth and Slick!"





Pump impeller and turbine rotor mounted on a single shaft of heat treated, forged "K" Monel (tensile strength 140,000 p.s.i. min.; yield strength 100,000 p.s.i., min.) with integral wearing sleeves at four points where shaft passes through turbine bearings, steam glands, pump bearings and pump gland. Propeller type impeller is of cast "H" Monel built by Worthington Pump & Machinery Corp.

Physical properties comparable with those of the alloy steels are developed in "K" Monel by heat treatment

THINK what it means in terms of modern design: A rust proof, corrosion resistant metal in which *the strength and hardness of alloy steel* can be developed by heat treatment! Typical of the improvement made possible by "K" Monel is the compact design of this turbo-propeller type pump:

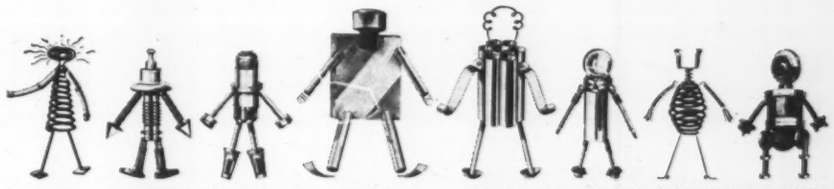
Used for salt water condenser circulating service, this direct-connected pump has a capacity of 19,500 gallons a minute. Yet it is only 6 ft. 3 inches in overall length! A single shaft carries both turbine rotor and pump propeller. Unique for such a high-capacity unit, this design is made possible by the exceptional strength, stiffness, hardness and wear resistance of rust proof "K" Monel.

Among the Nickel-copper alloys, "K" Monel is not the only one which offers an exceptional combination of properties. Along with resistance to corrosion and immunity to rust, each of the others offers special additional properties.

One of these alloys may be just the metal you seek. *Which one* depends on what you are designing. So why not submit the brief facts to our technical research men? They'll be glad to offer suggestions.

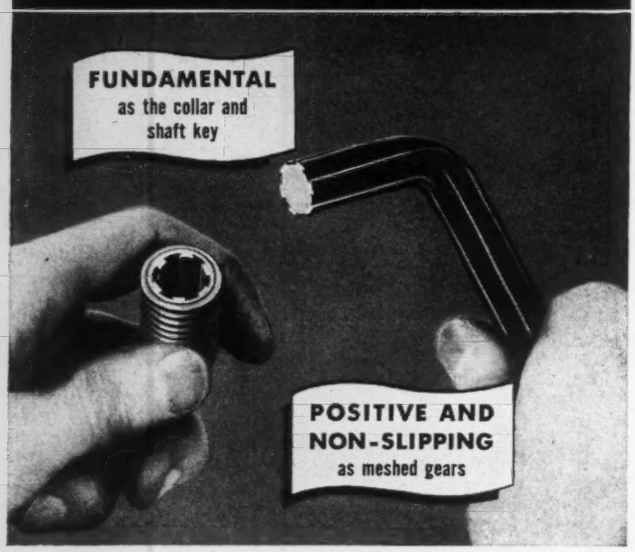
• • •

"Monel" and other trade-marks which have an asterisk associated with them are trade-marks of The International Nickel Company, Inc.



THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York, N. Y.

Multiple Spline is BASIC ENGINEERING DESIGN



Now offered by BRISTO in SOCKET SCREWS for tighter, faster, easier set-up

YOU know the multiple spline design as a time-proved way to transmit power unflinchingly. You've studied it in school. You've seen it used on automobile drive shafts, airplane propeller hubs and in many other important applications.

In incorporating the multiple spline design in socket screws, Bristo has given you a new brand of socket screw performance. A non-splitting, non-rounding out head, a lock-tight wrench engagement, a new ease and speed in tightening, a stamina and strength to withstand the shocks of severest service.

Add to all that, a saving in assembling time which brings production costs down, and you have the big reasons why industry prefers Bristo! Write today for your free copy of Bulletin 83-5N and samples of Bristo Socket Screws. No obligation. The Bristol Company, Mill Supplies Division, Waterbury, Conn.

FEATURES AT A GLANCE!

MULTIPLE SPLINE SOCKET—as positive acting as meshed gears—Won't split, shear, strip, round out, slip or jam—Sets tighter with less effort—No loosening under vibration—Takes wrench without fumbling or skidding.

BRISTO

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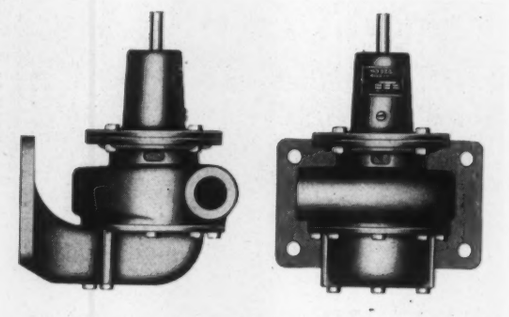
Multiple Spline
SET AND CAP SCREWS

Approved by the American Standards Association and the American Society of Tool Engineers

BRISTO MAKES YOUR PRODUCT BETTER

coupled installation, no auxiliary inlet piping being required. Units in the series are built in capacities up to 175 gallons per minute and pressures up to 53 pounds per square inch. The pumps are of the open impeller type permitting use of filters. Abrasives or other suspended foreign matter in the liquid will not damage or impair pump's efficiency or life. A special

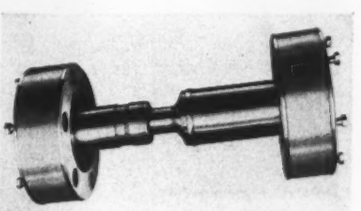


Pumps designed for use in conjunction with machine tools or auxiliary tanks where the unit is driven by belt, chain or gear

mechanical seal is used to eliminate shaft friction and the need for repacking. Necessity for maintaining pump locations in relation to liquid level is also eliminated, particularly in the F-VB model. No relief or bypass valves in the delivery line are needed to protect the pump or motor when the coolant supply is throttled.

Driveshaft Incorporates Coupling

THE Morflex radial coupling driveshaft brought out by Morse Chain Co., Ithaca, N. Y., combines the features of the standard Morflex radial coupling in a slip joint driveshaft for use as a remote drive, or where added flexibility may be necessary. The slip joint is full spline construction, grease tight, and slides freely under load. Shaft members are accurately machined from high grade steel forgings, piloted into coupling hub members and firmly welded. The entire shaft assembly is carefully balanced for smooth operation. Specially adapted for use on dynamometer drives and other installations in which endwise shaft float may be encountered, the unit is made in two types: The long coupled, where tubing is added to suit customers' requirements, and the short coupled, made up in one standard length. Both types are made in various sizes with capacity ratings



Radial coupling is combined with slip joint driveshaft for use as remote drive, or for flexibility

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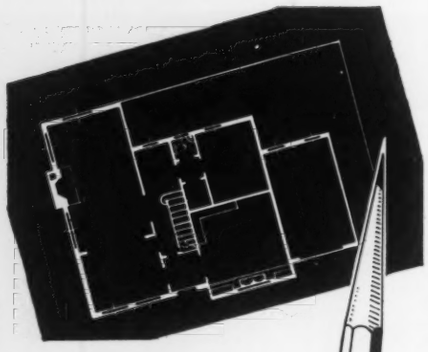
HYATT *Roller Bearings*



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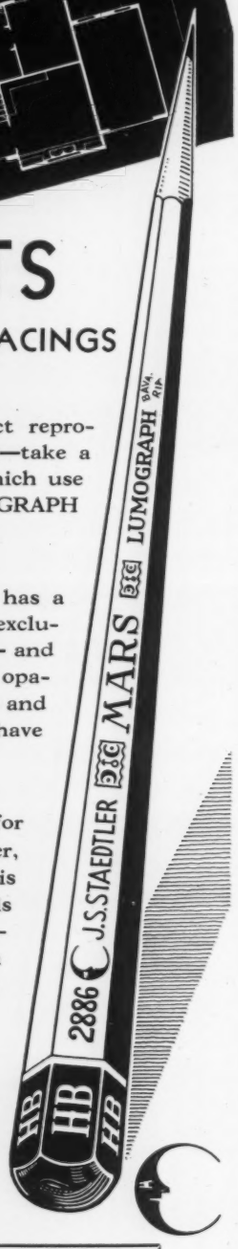

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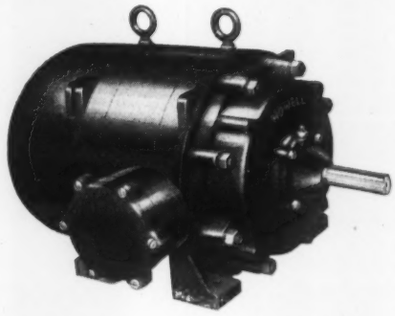
of from 2 to 27 horsepower per 100 revolutions per minute.

Motors Built for Flammable Locations

AN EXTENSION to its line of polyphase (Type EKBB) and single phase (Type EKCI) explosion-proof motors up to 40-horsepower has been announced by Howell Electric Motors Co., Howell, Mich. These motors are built for operation in locations where flammable liquids or gases are manufactured, handled or stored, and are totally enclosed.



Motors built for operation where flammable liquids or gases are manufactured or stored

The units will withstand the explosion of a flammable substance inside and prevent the flames produced by such an explosion from reaching the surrounding atmosphere, it is claimed. Heat capacity is great enough to prevent the motors, despite abnormal conditions, from reaching a temperature high enough to ignite surrounding gases.

Switch for Small Power Applications

THE roller leaf actuated switch announced by Micro Switch Corp., Peoria, Ill., is designed for service in applications where small moving power is available to make or break circuits and in applications requiring low friction, minimum change of operating point through wear, and where roller action is needed between the cam and the switch lever. It can be used to control motors, heaters, solenoids and the like

Micro switch, roller leaf-actuated, can be used where small movement is available to control motors, heaters, solenoids

from cams, slides, or rolls. Small and compact, the switch's overall size is 2½ inches long, 1⅝ inches high, and ¾-inch wide, and handles one-half horsepower. Either the standard or Type Z micro switch can be obtained with the roller leaf actuator, and can be supplied in metal-clad housings. This switch is of single-pole construction, and comes with normally open, normally closed, or double-throw contact arrangements. Leaf spring is stainless steel ribbed, for strength, tension, and life. The 3/16-inch wide roller, with a diameter of ⅜ inch, is case hardened

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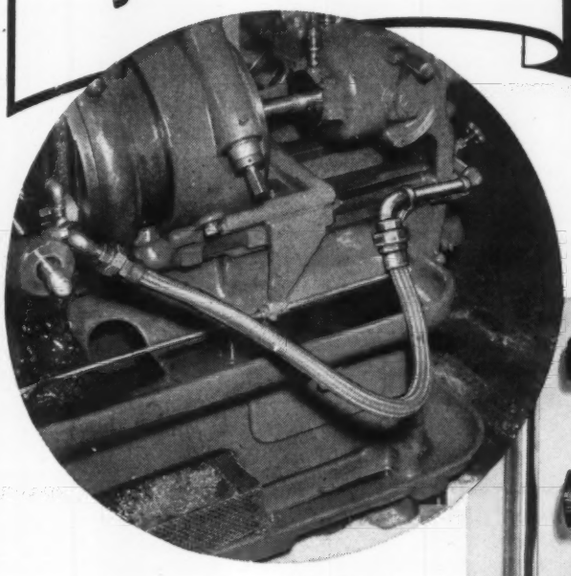
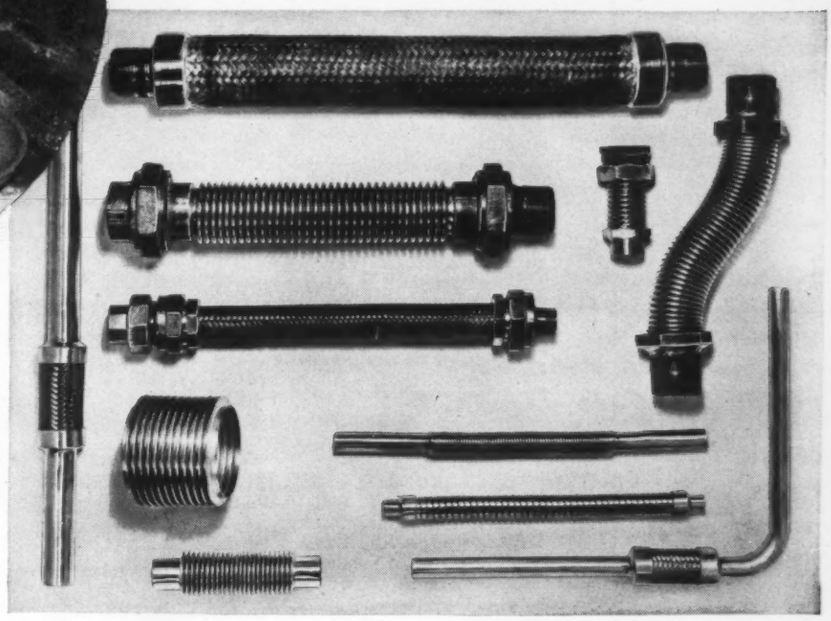
American Seamless Flexible Metal Tubing

The ideal method of conveying steam, oil, air, liquids and gases to moving mechanisms



ABOVE— *American Seamless Flexible Bronze Tubing with soldered on couplings for conveying coolant oil on a modern machine tool.*



RIGHT—*Just a few of the many thousands of special assemblies that we have designed for specific application in modern machine design. Let our engineers submit their suggestions for solving your problem.*

MODERN DESIGN ENGINEERS are agreed that the one best method of heating, cooling or lubricating moving parts on machinery involves the use of *all metal* flexible hose and tubing. Because in metal they can be certain of obtaining dependable connectors with the strength and ruggedness of the machine itself. No wonder then that American *Seamless* enjoys such widespread popularity with leading machinery designers.

American *Seamless* is actually made of seamless tubes —corrugated to assure extreme flexibility and jacketed with wire braiding to impart maximum strength. It's the ideal flexible connector for misaligned or moving parts . . . for absorbing vibration . . . for the dependable conveyance under pressure of air, steam, oil, water, and gases. American *Seamless* is *all metal*— with no joints, welds, laps, seams, or packing of any kind. It's the toughest tubing you can buy.

Write us about your connector problems. Our engineering department has complete information on the use of American *Seamless* on all types of equipment. When writing ask for our free reference handbook, Bulletin SS-25.

39241

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Write for Bulletin Number 37 and list of stock sizes

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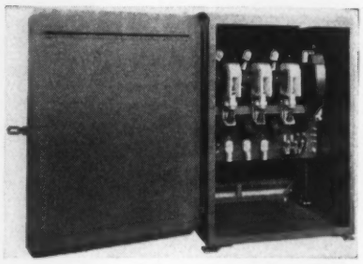
and mounted on an oilless bronze bearing, true roundness being held within .002-inch.

Develop Nonreversing Linestarters

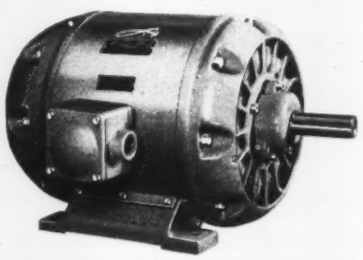
NONREVERSING linestarters finding their chief application in across-the-line starting of large squirrel cage motors and as primary switches for wound-rotor induction motors are now being manufactured by Westinghouse Electric & Mfg. Co., East Pittsburgh. Typical applications include pumps, compressors, fans and blowers or any application requiring pushbutton or remote control where across-the-line starting is permissible. The linestarters come in four sizes. Distinctive features of the units include low-voltage protection or release through low-voltage relay, bimetal type of overload relay, hand or automatic reset, saturated current transformers insuring adequate protection on slow starting applications, and strong magnetic blowouts for adequate arc-rupturing capacity.



Chief application of nonreversing linestarters is across-the-line starting of large squirrel cage motors

Motors Withstand Internal Explosion

LOUIS ALLIS CO., Milwaukee, has brought out a new line of explosion-proof motors with cast iron construction of the entire stator housing and end bells. The enclosure is designed with a high safety factor to withstand any likely internal explosion pressure. For convenience, the cartridge bearing cap has been designed to enable easy and quick inspection of the bearings without removing the end bells. Only three head screws need be removed. Although ample size ball bearings, completely protected in the bearing cartridge, are supplied as standard, roller or double row ball bearings on the shaft or load end are available. End bell and air deflector is of heavily ribbed one-piece construction, the blast of



Enclosure of explosion-proof motor has high safety factor, stator housing and end bells being heavily-ribbed iron

Get this Point!

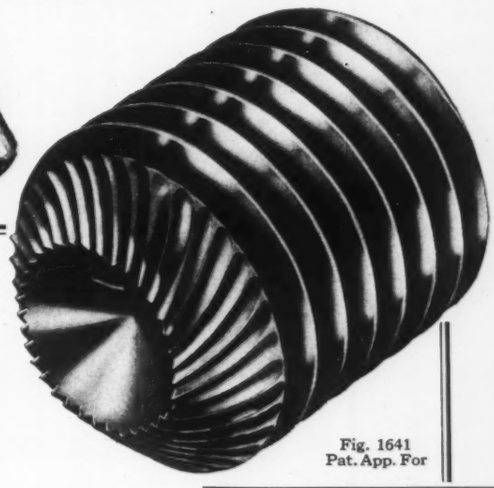


Fig. 1641
Pat. App. For

UNBRAKO

SELF-LOCKING HOLLOW SET SCREWS

with the Knurled Points

will protect your machines from accidents or breakdowns caused by ordinary set screws working loose.

Tests and actual usage prove that once tightened up, these screws will hold tight despite vibration, shaking or jarring. They are no trouble to install and they can be easily taken out with an ordinary wrench for making adjustments and used over and over again. Why take chances when you can be sure the "Unbrako" Self-Locker will not fail you.

Send the coupon for facts and figures.

STANDARD PRESSED STEEL CO.

BRANCHES: BOSTON, DETROIT, INDIANAPOLIS

JENKINTOWN, PENNA.

BOX 102

BRANCHES: CHICAGO, ST. LOUIS, SAN FRANCISCO

Send me all the facts about "UNBRAKO" Self-Locking Set Screws and Self-Locking Square Head Set Screws

NAME..... TITLE.....

COMPANY.....

ADDRESS.....

KNURLED POINT

UNBRAKO

SELF-LOCKING Square Head SET SCREW stays put in spite of severe vibration

Now "Unbrako" Square Head Set Screws have this unique added feature . . . they automatically lock in place just by being turned up tight in the normal manner. The knurled points do the trick. These screws can be removed with ordinary wrenches and re-used indefinitely.

Fig. 1646
Pat. App. For

Diebold Safe & Lock Co. find Molded Plastics ideal for their Cardineer Wheels. Molded of plastics they are lighter, more durable, better in appearance and lower in cost than if made of stampings or die castings. Moreover, molding in plastics eliminates all welding, plating, painting and difficult machining operations. Into each of these large, half-sections are molded the steel axle, brass bearing pins and bolt holes with precision of location that insures a simple final assembly. Mold designed and made and parts molded

by

CHICAGO MOLDED PRODUCTS CORP.
1028 No. Kolmar Ave. Chicago, U.S.A.

DEPENDABLE – YEAR AFTER YEAR
You get long, trouble-free service from Tuthill Small Pumps, thanks to the combination of quality materials, precise engineering skill, research and experience. That's one reason why design engineers specify these dependable small pumps. Capacities from 1/3 to 3 g.p.m. Pressures up to 400 lbs. per sq. in.
Write for Small Pump Catalog today
TUTHILL PUMP COMPANY
941 EAST 95TH STREET, CHICAGO, ILLINOIS

cooling air being directed over the stator housing and deflected through the vents. These motors are equipped for grease lubrication but they may be obtained for oil lubrication.

Switch Uses Mercury Button

A NEW general purpose switching mechanism employing the "mercury button" has been announced by General Electric appliance and merchandise department, Bridgeport, Conn. Designed for installation on electric appliances, this new switching mechanism is made with the "mercury button" placed at eight different angles for flexibility in mounting. It may be mounted in any 45-degree position in the vertical plane. There are no springs or blades to wear out and no contacts to deteriorate. The "mercury button" consists of mercury-to-mercury contacts enclosed in two special alloy metal disks which are glass-sealed on a ceramic barrier. Hydrogen gas in the button prevents oxidation of mercury and cools and quenches the arc when the circuit is broken.

Photoelectric Receiver Announced

DESIGNED for fuels other than gas, burning with luminous flames, the Photo-Head photoelectric receiver has been introduced as an adjunct to the Wheelco Flame-Otrol safeguard by the Wheelco Instruments Co., 1933 South Halsted street, Chicago. The Photo-head takes the place of a standard electrode, affording instantaneous protection against

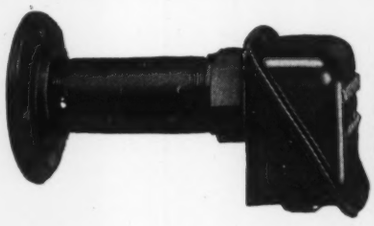


Photo-Head photoelectric receiver designed to take the place of standard electrode

flame failure. It provides safe automatic ignition for oil burners and is sensitive to characteristics of a luminous flame but not responsive to heat radiation from the combustion chamber. In conjunction with the Flame-Otrol, it shuts down the fuel supply quickly, preventing entry of unburned fuel into the combustion unit and eliminating this source of explosion hazard.

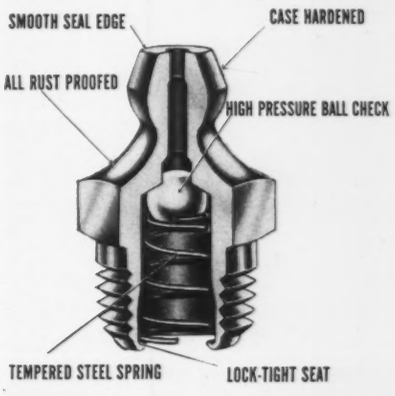
Radial Couplings Withstand Loads

IN THE Morflex radial coupling announced by Morse Chain Co., Ithaca, N. Y., specially shaped rubber bushings are used which provide an effective flexing medium for withstanding shock loads and resisting vibration. These rubber blocks are assembled radially, equally spaced, on the steel pins of the yoke or hub member. A two-piece metal housing encases the rubber blocks and also provides for at-

★ ★ ★

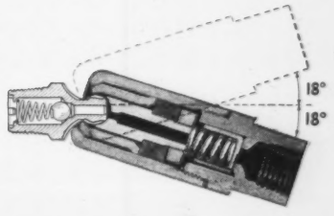
NOT A SINGLE BEARING FAILURE

SINCE ADOPTING ALEMITE



THE ALEMITE HYDRAULIC FITTING—THERE'S NO OTHER LIKE IT

When you choose Alemite Hydraulic Fittings to safeguard important bearings, you are getting the best, most dependable fitting that has yet been made. Case-hardened to resist breakage—cadmium-plated to resist rust—every fitting individually inspected and tested! Accurately engineered by the originators of pressure lubrication to give your machines maximum protection!

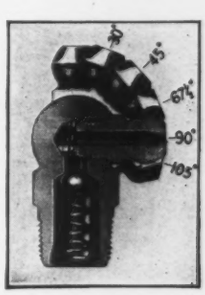


HERE'S HOW HYDRAULIC GUN WORKS ON HYDRAULIC FITTING

See how the coupling of the Alemite Hydraulic Gun grips the nose of the Alemite Hydraulic Fitting to form a leakproof seal—a seal which grows tighter as pressure is increased! Gun may be arced as much as 18° in any direction without breaking the seal, for greater convenience in reaching remote bearings.

HYDRAULIC FITTINGS AVAILABLE IN ANGLES

Alemite Hydraulic Fittings are made in all desired angles to facilitate the lubrication of remote bearings, and are cyanide hardened to stand up under severe use over a long period of time. Every fitting must stand rigid factory inspection before shipment.



ALEMITE HYDRAULIC GUN
MODEL 5586

Holds 9 oz. semi-solid lubricant; quickly filled through filler-type handle with Alemite Filler Tank; easily operated with one hand—can't slip off fitting. Delivers predetermined quantity of lubricant at each shot; up to 10,000 lbs. pressure per sq. in. Gun coupling has three jaws which grasp fitting on contact, forming leakproof seal.

WHEN YOUR MACHINES ARE ALEMITE-EQUIPPED, NO EXPLANATIONS OR APOLOGIES ARE NEEDED

INDUSTRY *knows* Alemite Lubrication! When you tell your prospective customer that your new machine is factory-equipped for Alemite Lubrication, *that's all he needs to know.* You have told him, in a word, that you're providing the best. *He recognizes that fact.* He knows that, with conveniently placed Alemite Fittings inviting frequent lubrication, he will not be troubled with bearing failures and his maintenance costs will be low.

Take the case of the Narragansett Brewing Company at Cranston, R. I. They adopted Alemite Lubrication something over eight years ago. *And they haven't had a bearing failure since*—although such trouble occurred frequently before that time! If you were selling Mr. Carney of Narragansett a piece of new brewery machinery, and told him it was equipped for Alemite, *there would be no more questions about lubrication.* And that's typical of the way industry feels about Alemite.

Insure longer life and lower maintenance costs for your machines by using Alemite Fittings and Guns as standard equipment! Remove one important sales hurdle by settling lubrication once and for all—*so you'll never have to take time to explain or apologize!* Alemite engineers will be delighted to confer with you on any special lubrication problem, without obligation on your part. Write to us for detailed suggestions on any problem.

ALEMITE

REG. U. S. PAT. OFF.

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Stewart-Warner-Alemite Corporation of Canada, Ltd., Belleville, Ontario

WORLD'S LARGEST MANUFACTURER OF LUBRICATION PRODUCTS

This

SELF-LOCKING NUT

is solving tough fastening problems in every industry

STANDARD fastening device of the aircraft industry... universally used on rock drills where no other nuts will hold . . . widely accepted as the nut which will not back off under any condition of vibration or stress.

THE Elastic Stop self-locking element is composed of a resilient non-metallic material which does not fatigue or fail, does not damage bolt threads, and is not affected by immersion in water, oil, or other liquids.

The Elastic Stop principle is clearly explained in an extensively illustrated catalogue. Write for a copy.

ELASTIC STOP NUT CORPORATION
1011 NEWARK AVENUE • ELIZABETH, NEW JERSEY

Elastic Stop SELF-LOCKING NUTS

FREE- TRANSIT AND HIGHWAY MAP

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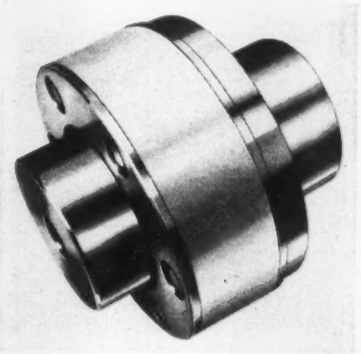
MD-4-39

taching the companion flange to the unit. The entire coupling is machined to insure perfect balance.



Radial coupling uses specially shaped rubber bushings to provide effective flexing medium for withstanding shock loads

Since there is no metal on metal movement the coupling is fully insulated against noise and electricity and requires no lubrication. The coupling is made in various sizes with capacity ratings of from 2 to 37 horsepower at 100 revolutions per minute.

Pulleys for Belt Drives Announced

NEW pulleys for flat belt drives have been put on the market by Vacuum Cup Metal Pulley Co. Inc., 12536 Grand River avenue, Detroit. Action of air in cups in the surface of the pulleys, it is claimed, holds the belt firmly in place as it passes over the pulley. As the belt surface leaves the pulley it moves forward without resistance.

Motor for Textile Industry

A LINT-FREE motor designed specifically for textile industry use as an individual drive on machines such as spinning and twisting frames, pickers, roving frames and winders has been introduced by Westinghouse Electric & Mfg. Co., East Pittsburgh. It offers minimum possibility of collecting lint and is easily cleaned. Almost frameless as far as enclosure or ventilation construction is concerned, the unit retains the sturdiness of a general purpose motor. The construction provides clear visibility into the interior, allowing easy and economical cleaning by hand or air hose without disassembling.

Self-Locking Bearing in Pillow Block

THE Rubber-Flex pillow block, comprising a self-locking bearing, has been introduced by SKF Industries Inc., Philadelphia. This Grip-Lock bearing is inherently aligning, thus compensating for inaccuracies of setup and conditions of shaft misalignment without binding or in any way impairing the load-carrying capacity of the bearing. The bearing is encased in a pressed steel housing equipped with felt seals to exclude dirt, and the housing is provided with means for lubricating the bearing. Surrounding the bearing and housing is an elastic material having special

SCALES, INLAID IN FORMICA TABLE TOPS FOR INDUSTRIAL USES!

Formica table tops for industrial uses are made more useful by inlaying scales in the surface sheet of Formica for quick and accurate measurement of any thing that needs to be matched or graded. The picture shows such a table top in use in the Real Silk Hosiery Mills at Indianapolis for the inspection of silk hosiery.

The scale is always at hand. It is smooth and flat with no sharp corners or surfaces that can do injury to the product. It contributes to speed and reduces spoilage. The color may be white.

Such scales, inlaid in Formica, can be designed to meet your particular requirements.

THE FORMICA INSULATION COMPANY
4673 Spring Grove Avenue, Cincinnati, Ohio

FORMICA

FLAMENOL WIRE

IS EASY TO STRIP

WITH a sharp knife, or wire-stripper, you can easily remove the single covering of Flamenol on this wire—and make connections in a jiffy. You thus save time.

You save, too, in other ways. Space, for example. Flamenol has such high dielectric and mechanical strength that a single covering serves both as insulation and finish; and the wire, for say 600 volts, is smaller in diameter than any other insulated wire.

These and other unique properties—twelve colors, resistance to flame, water, oil, acids, and age—make Flamenol ideally suited for low-voltage wiring on such high-grade equipment as machine tools. You'll find that it will solve difficult wiring problems on your product. A G-E cable specialist will gladly help. Address nearest G-E sales office or General Electric Company, Department 6—201, Schenectady, N. Y.

INSULATED WIRE ALWAYS THE RIGHT TYPE FOR EACH JOB

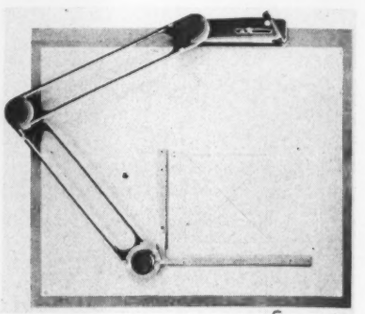
GENERAL ELECTRIC

520-150

sound-absorbing characteristics, treated to make it impervious to oil and grease. These units are first being released in the ¾-inch and 1-inch shaft sizes.

Drafting Machine Has Parts Enclosed

UNIVERSAL drafting machine Model 77 has been announced by Universal Drafting Machine Co., 1426 West Third street, Cleveland. Its arm completely encloses bands and working parts, protecting the designer or draftsman and minimizing accumulation of dirt between bands and wheels. The convenient and comfortable protractor is properly located above the arm to provide freedom of manipulation and full-circle vision. For slightly inclined boards a frictionless spring support is provided and the machine is equipped with precision ball bearings. A secondary 360-degree protractor movement with thumbscrew clamps makes possible rapid alignment of the protractor to the drawing, or to any other desired baseline. Stops of 30, 45 and 60 degrees may thus be used from any angle.



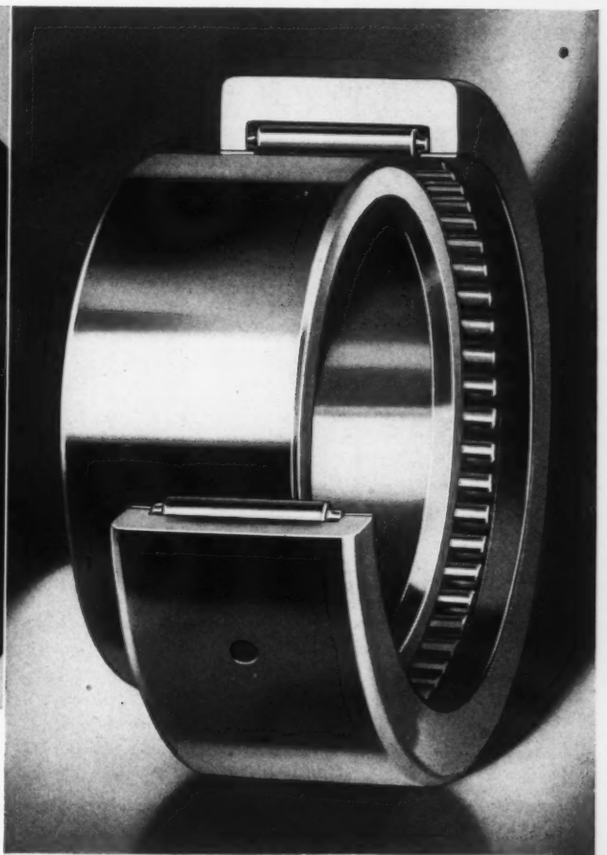
Bands and working parts of universal drafting machine are covered by enclosing arms

Portable Printer Is Developed

ANNOUNCEMENT has been made of a new portable printer for duplicating tracings, drawings, charts, records, letters, etc. Made by the Keene Appliance Co., 201 First National building, Ann Arbor, Mich., the printer uses a special sensitized paper and makes positive contact prints up to 12 x 18 inches. The printer measures 22 x 16 x 11 inches and weighs less than 33 pounds.

Special sensitized paper is used in portable printer for positive contact prints developed in five minutes

New Type QUILL BEARING WINS QUICK APPROVAL



REQUIRES LESS SPACE

EASIER TO ASSEMBLE

HIGHER LOAD CAPACITY

DEFINITELY LOWER COSTS

GREATER RELIABILITY

WIDE RANGE OF SIZES CARRIED IN STOCK

IN all Bantam history no one bearing has ever received more instant and enthusiastic approval than this new STANDARD SERIES QUILL BEARING. Test installations in a wide range of industries have brought impressive repeat orders and many letters which say: "This is just the kind of a bearing we've been looking for."

The advantages listed at left are a result of the following features: 1—One-piece channel-shaped race, with rigid surfaces, providing solid abutment for end of rollers. 2—Correctly proportioned rollers, accurately hardened and ground. 3—Husky curvilinear trunnions. 4—Positive retaining band which functions only during roller assembly. 5—Simplified design—no fragile parts.

Built to the same high quality as the Bantam Quill Bearings used on the famous Diesel-powered streamline trains, the low cost of this new-type bearing is due solely to simplified design and standardized quantity production. Prompt shipment from stock in shaft sizes from ½" to 5".

Write for Bulletin 103B which gives complete engineering data. For Needle Bearings to be used in lighter service write our affiliate, The Torrington Company, Torrington, Conn., and ask for Circular 19A.

BANTAM BEARINGS CORPORATION

SOUTH BEND, INDIANA

Subsidiary of THE TORRINGTON CO.
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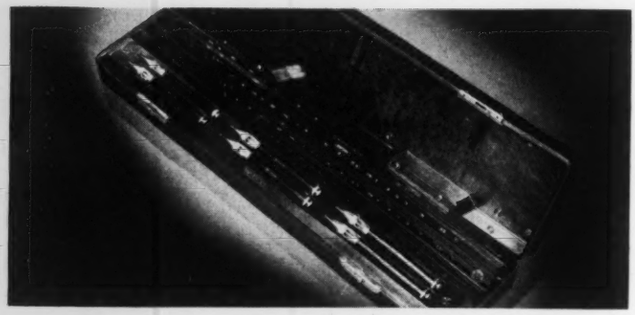
BANTAM BEARINGS

TAPERED ROLLER • • • STRAIGHT ROLLER • • • BALL BEARINGS



WHY A ROUTINE JOB BECAME
A FIRST PRIZE WINNER

There's no secret about the Wood-Regan molded Bakelite case for WRICO Lettering Guides, which captured first place in the Plastic Container Division of the 1938 All-America Package competition.

To us it was a routine job. But back of that routine was more than 60 years experience. There was the painstaking creation of dies, careful workmanship and the long series of rigorous inspections which guarantee the accuracy and quality of *every* Auburn job.

All of which proves that the same skill and experience which consistently produces sales winners produces prize winners also. Let us put this experience to work for you.

Established 1876

MOLDED PLASTICS DIVISION OF
AUBURN BUTTON WORKS, Inc.
AUBURN, N. Y.—New York, Chicago, Detroit, Cleveland, Rochester, Boston

LUBRICATED FOR LIFE
The machine tool market asks for more pieces per hour. The machine tool asks for higher speed and more automatic control. The machine designer asks for ideas.
Let us help. Our engineers are ready to show you how Pulsolator can automatically lubricate your machines for life.
write for bulletin b-30
Rivett
Lathe & Grinder Inc.
Brighton, Boston, Mass
Automatic Oil Lubrication
BLANCHARD PULSOLATOR

Meetings and Expositions

April 13-15—

Armour Institute of Technology, with the co-operation of Iowa State College, Purdue university, State University of Iowa, Universities of Illinois, Michigan and Wisconsin, as well as local and national engineering societies, will hold Midwest Power Conference at LaSalle Hotel, Chicago. L. E. Grinter, Armour Institute of Technology, Chicago, is conference director.

April 18-20—

Machine Tool Electrification forum. Annual meeting to be held in East Pittsburgh. R. S. Kersh, Westinghouse Electric & Mfg. Co., East Pittsburgh, is director.

May 13—

Eastern Photoelasticity conference. Ninth semiannual conference to be held at Cornell university, Ithaca, N. Y. Prof. F. G. Switzer of the College of Engineering, Cornell University, Ithaca, N. Y., is chairman.

May 15—

Gray Iron Founders' Society Inc. Annual meeting to be held at Netherland-Plaza hotel, Cincinnati, O. C. I. Ritchie, 1010 Public Square building, Cleveland, is executive secretary.

May 15-18—

American Foundrymen's association. Annual convention to be held in Cincinnati. R. E. Kennedy, 222 West Adams street, Chicago, is secretary.

May 22-23—

American Society of Refrigerating Engineers. Annual meeting to be held at Hotel Hershey, Hershey, Pa. Additional information may be received from headquarters at 37 West 39th street, New York.

May 22-24—

American Gear Manufacturers' association. Annual meeting to be held at Cavalier hotel, Virginia Beach, Va. J. C. McQuiston, 602 Shields building, Wilkinsburg, Pa., is manager-secretary.

May 24-26—

Association of Gas Appliance and Equipment Manufacturers. Annual convention to be held at Roosevelt Hotel, New York. Further information is obtainable at headquarters, 60 East Forty-second street, New York.

149 POUNDS PER CAR IS STEEL CASTINGS

The Ford Motor Company has a well-earned reputation for two outstanding accomplishments — constantly improved product, and increasingly greater customer value.

It is significant that this great company is using an ever increasing number of Steel Castings — now at least 149 pounds in the chassis of every car produced.

Mr. R. H. McCarroll, Ford Metallurgist, says:

> "— While numerous manufacturing advantages result from change to steel castings, we would like to emphasize that cast steel parts have almost always given better results in actual service, and always at least as good. Another requirement is that the cast steel part must never weigh more. In almost all cases the weight has been less."

Such a statement has authority. Ford never turns cost corners on two wheels. Performance must come first.

You too can improve your product and save money by a wider use of Steel Castings. Your local foundry will be glad to work with you. Or you may prefer to consult Steel Founders' Society of America, by whom this advertisement is published. Address 920 Midland Bldg., Cleveland. No obligation, of course.

IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

BRING YOU THESE ADVANTAGES

1. Uniform structure, for greater strength, shock and stress resistance.
2. Metal distributed where it will do the most good; maximum strength with minimum weight.
3. Widest range of physical properties.
4. Good machining qualities, low finishing costs, better streamlined appearance.
5. High rigidity, minimum deflection, accurate alignment, close tolerances and better fit.
6. Readily weldable in composite structures.
7. High fatigue resistance, maximum endurance and longer life — ideal for critically stressed parts.

Steel Founders' Society

STEEL CASTINGS

THE GUSHER COOLANT PUMP

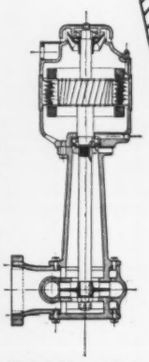
PRECISION BUILT
WITHOUT EXTERNAL PIPING

A ball bearing coolant pump that is easily mounted—designed to give years of trouble-free service. End your pump problems by using "Gushers".

QUIET

"Gusher" Pumps have split-second volume control, are hydrostatically balanced, self-cleaning and safely handle materials that contain grit and abrasives.

Model No. 11020A



Model No. 11022 Patented and Patents Pending

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Directory of Materials
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Write now for this comprehensive listing of materials, including alloys, plastics and other nonmetallics; also producers of stampings, forgings, die castings, and plastic molders. Twenty-five cents per copy. Special schedule of rates for copies in quantities.

Designing Mechanical Springs for Machine Use

By Dr. A. M. Wahl

Limited number of reprints of this four-part series still available. Price fifty cents per copy.

MACHINE DESIGN
Penton Building Cleveland, Ohio

farm tractor. Later he supervised the development of the all-purpose tractor, and from 1908 to 1914 was in charge of the tractor works, Chicago. In 1915 he was made assistant manager of the engineering department; in 1922, manager of engineering; and in 1934, engineering vice president, his position before retiring. Mr. Johnston has also worked on cotton picking equipment for approximately thirty years and has been in charge of development of an experimental mechanical picker.

♦

RALPH EVINRUDE was recently appointed president of Outboard, Marine & Mfg. Co., Waukegan, Ill.

♦

ARTHUR J. WILLIAMSON has been added to the technical staff of Summerill Tubing Co. as metallurgical engineer in charge of research and development.

♦

FREDERICK W. COPELAND has resigned, as president of H. Channon Co., to become president of the Sullivan Machinery Co.

♦

EDWARD WARNER, who has been assisting the Civil Aeronautics authority in a consulting capacity, has been appointed economic and technical adviser to the authority. He is professor of Aeronautical engineering at the Massachusetts Institute of Technology.

♦

E. O. BEHNE, who previously was connected with Defiance Machine Works, has been made chief engineer in charge of engineering and development of Reed-Prentice Corp., Worcester. A. F. SCHOEPFLIN has become consulting engineer with the company, specializing in its die casting process. Mr. Schoepflin was for thirty years identified with Doehler Die Casting Co.

♦

JULIUS E. GRAF, assistant chief engineer, Carnegie-Illinois Steel Corp., has joined Treadwell Engineering Co. as vice president in charge of engineering.

♦

MALCOLM W. REED, formerly vice president in charge of operations for American Steel & Wire Co., has been named chief engineer, succeeding SYDNEY DILLON, recently transferred to the office of the chief engineer of the U. S. Steel Corp.

♦

F. MALCOLM FARMER, vice president and chief engineer of Electrical Testing Laboratories, New York, has been nominated president of American Institute of Electrical Engineers. Mr. Farmer, whose career was covered in more detail in December, 1936, MACHINE DESIGN, is also director of American Standards association, and is a past president of both American Society for Testing Materials and American Welding Society.

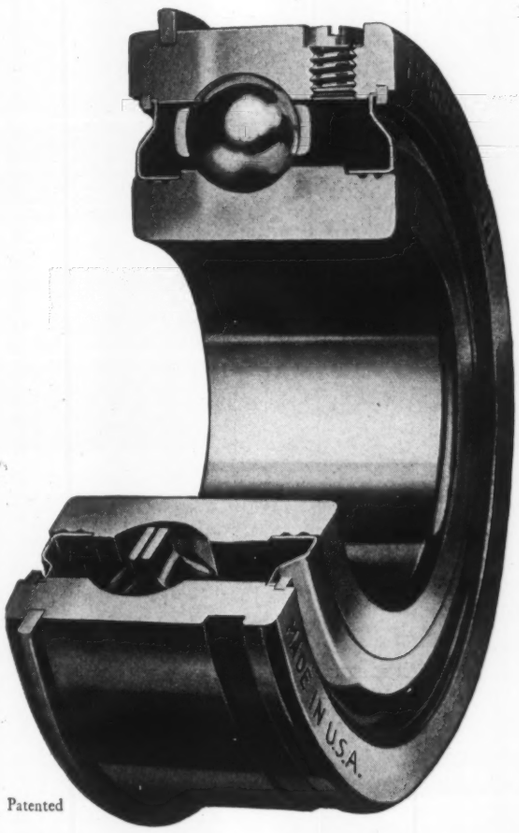
CARTRIDGE

SIMPLIFY YOUR DESIGN—DOUBLE YOUR GREASE CAPACITY—

ELIMINATE DIRT HAZARD

WITH THIS

Ideal Self-Sealed Bearing



Patented

MADE TO STANDARD DOUBLE-ROW WIDTHS WITH 100% GREATER GREASE CAPACITY

Available in Four Different Series

"3600" . . . . . with standard outer ring.
"43600" . . . . . with shoulder ring in outer ring.
"3600-J" . . . . . with refilling plug in outer ring.
"43600-J" . . . . . with shoulder ring and refilling plug in outer ring.

Can be packed with at least 100% more grease than any other self-sealed bearing—especially adapted, therefore, for continuous service for long periods.

Eliminates the dirt hazard and insures absolute retention of lubricant—by the use of flanged metal shields, recessed inner ring construction and two or more grease grooves, the combination affording a truly effective labyrinth.

Is equally efficient in retaining grease in horizontal or vertical position.

Flanged metal shields, though rigidly located by snap rings, are removable to facilitate inspection, cleaning or re-greasing of bearing.

Can be quickly regreased, either through built-in refilling plug opening or by removing metal shields.

Requires no lock nuts on shaft or clamping means in housing, because of wide contact areas due to double-row width of both rings—which also safeguard against "cocking" and prevent slippage or "peening".

Shortens over-all length of mounting and reduces overhang of shaft.

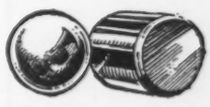
Reduces costs by simplifying design, eliminating protective closure parts, and saving attendant labor.

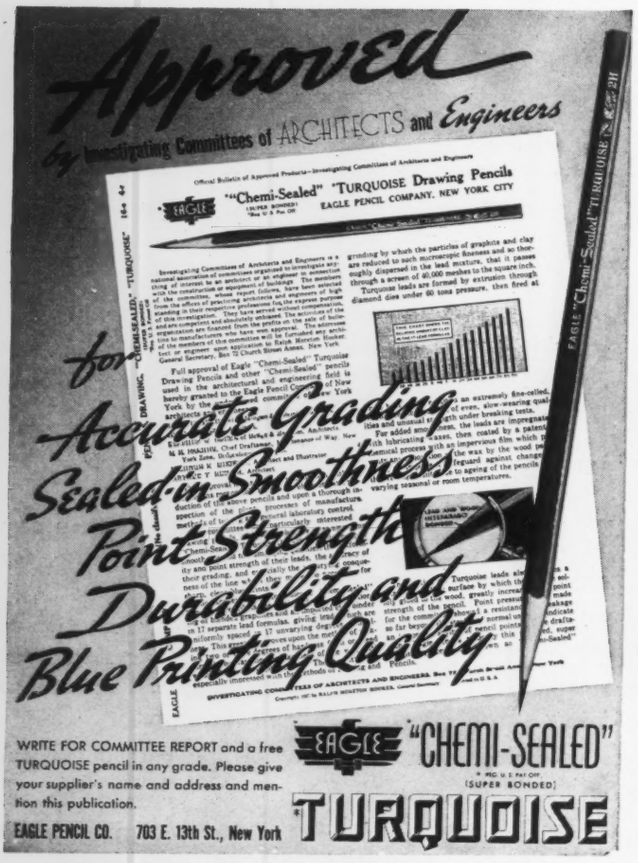
Available with shoulder ring, thus permitting a through bore in housing, the shoulder ring providing endwise location.

Placed on the market only after years of exacting tests in our laboratory and in the field under continuous operation, the "CARTRIDGE" BEARING has conclusively demonstrated its ECONOMY, EFFICIENCY and SUPERIORITY. A constantly increasing number of representative manufacturers of electric motors, machine tools, pumps, woodworking machinery, and other equipment is adopting it because of its proved merit. Write for Catalog showing typical "Cartridge" mountings.

NORMA-HOFFMANN BEARINGS CORP'N., STAMFORD, CONN. U.S.A.

BEARING

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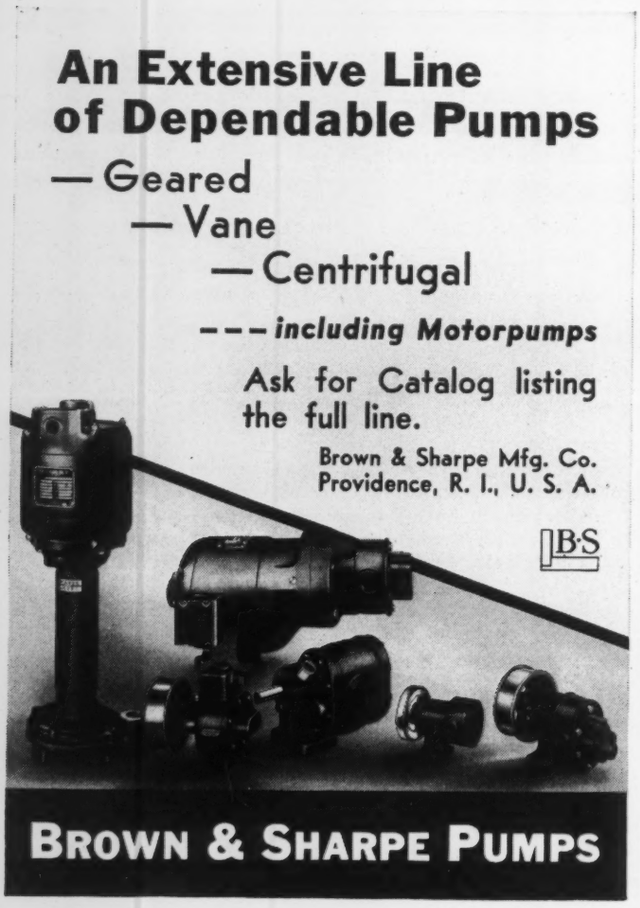
(SUPER BONDED)
TURQUOISE



Topics

PEDRO the Voder is on exhibit by the Bell Telephone System at the San Francisco exposition and will also put in an appearance at the New York World's Fair. Pedro, the machine which talks because its electrical mechanism corresponds to that of human speech in all the essentials of sound and completeness of their control, is named for an emperor of Brazil. The monarch, at the Philadelphia exposition of 1876, heard human speech over a telephone receiver in Alexander Graham Bell's booth, and blurted, "My God, it talks!" Last part of the name, "Voder," is taken from the italicized letters of the machine's official title, "*V*oice *O*peration *DE*monstrato*R*." Resembling a small old-fashioned organ, with a keyboard and pedal, the Voder has electrical equipment corresponding to the two kinds of sound in human speech. An electrical source in the machine corresponds to the vocal cords and gives a saw-tooth wave of definite pitch. A pedal changes this pitch and gives speech a rising or falling deflection as desired. Particular parts of sounds wanted are selected by playing proper keys. Each key operates a variable attenuator to control the current in a definite frequency range, the source of current for each attenuator being an electrical filter which picks from the saw-tooth wave one particular group of overtones.

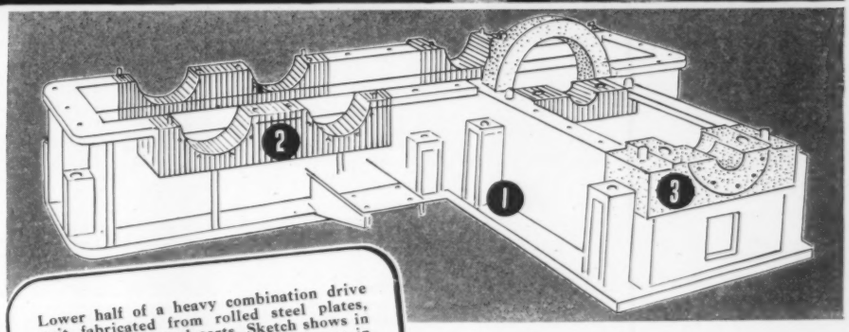
♦

DESIGNERS who have seen their handiwork seriously damaged through improper or infrequent lubrication are interested in means for controlling the oiling of equipment. Separate colors are being used to identify lubricants for various purposes and kinds of machines; other colors indicate the frequency of application. Drums of lubricant and the machines themselves may then be marked with the proper two colors, to aid in preventing errors by operators who may become lost in the maze of oils used in modern industry. For example, if red indicates an oil to be used on speed reducer gears and blue a daily application, a drum marked red and blue would lead the operator to oil speed reducers once a day.

♦

IN THE United States, airplane parts and fuel specifications have become pretty well standardized, but a chaotic condition exists in this respect when American airplanes are exported. American manufacturers, when servicing engines and aircraft sold abroad are constantly pressed by foreign customers to use interchangeable parts so that, for example, an American engine shaft will fit European propeller butts. Recently the principal aeronautical organizations of this country met with the American Standards association and decided to co-operate in the development of international standards in the field.

TO MAKE YOUR ROLLED STEEL CONSTRUCTION *More Efficient...* we offer these More Efficient Steels



Lower half of a heavy combination drive unit fabricated from rolled steel plates, slabs, and cast steel parts. Sketch shows in white (1), parts fabricated from plates; in hatched areas (2), parts flame-cut from slabs; in dotted areas (3), cast steel parts. Rolled steel construction makes it possible to combine effectively the right steels for maximum functional efficiency.

U·S·S HIGH TENSILE STEELS

To carry high unit stresses and to reduce weight to a minimum at low cost. (U·S·S Cor-Ten has resistance to atmospheric corrosion 4 to 6 times greater than plain steel.)

U·S·S ABRASION RESISTING STEELS

To reduce abrasive wear wherever earth, sand, gravel, waste, etc., flow over, through or against your equipment. Costs little more than plain carbon steel.

U·S·S CARILLOY ALLOY STEELS

To strengthen vital parts—to carry tremendous bearing pressures safely. Steels to resist creep at elevated temperatures and pressures.

U·S·S STAINLESS STEELS

To resist corrosive environments. To assure long life. Special analyses can be welded with no loss in corrosion resistance.

U·S·S HEAT RESISTING STEELS

To endure high temperatures that spell disaster to other metals.

THE advantages of rolled steel construction are many. Light weight, lower cost, improved appearance, freedom of design—these are the reasons why designers are now turning to this method of building equipment.

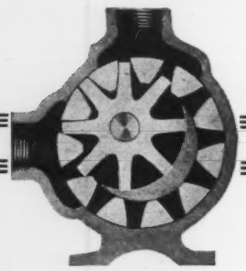
You can sum up all these advantages with this single statement: *Rolled steel construction permits the ultimate in functional efficiency.*

To make the most out of rolled steel construction, we offer you the widest available range of metallurgy's finest steels, plus the services of experts trained in the job of selecting the right steel for a given application. You can rely on our specialists' recommendations, because they have a complete range of steels from which to choose. They are not interested in promoting any one grade or alloy over any other. Their sole interest is in helping you get the steel that will do the best job at lowest cost. Ask one of these engineers to call.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

It's the PRINCIPLE of the thing that COUNTS



★ In 28 years, no rotary pump manufacturer has introduced a pumping principle equal, either in efficiency or performance, to that of the Viking world-famous "Gear Within A Gear" principle. Built into EVERY Viking Rotary Pump, this principle is your guarantee of a better pumping job FREE from costly repairs and delay.

To all Machine Tool Manufacturers, Bulletin 302-34 will prove both interesting and informative . . . write for your copy today.

VIKING PUMP CO.
CEDAR FALLS, IOWA.

Photo courtesy The Heald Machine Co.

AVIATION'S NEW TYPE OIL LINE HOSE NOW ADAPTED TO MACHINE TOOL APPLICATIONS

Several leading machine tool builders now specify AVIOFLEX. Completely impervious internally to hot hydrocarbon fluids due to use of laminated cellulose sheets wrapped over a specially profiled flexible metal core. Also resistant externally to hot oils. AVIOFLEX construction assures great strength, practically unlimited flexing life. Data, sample, on request.

CHICAGO METAL HOSE CORPORATION
MAYWOOD, ILLINOIS

MANUFACTURERS' *publications*

BEARINGS—The Ball and Roller Bearing Co., Danbury, Conn., has published illustrated catalog No. 15 describing its numerous types of ball and roller bearings for many uses. Specifications and prices are listed. Of particular value to designers is additional information on allowable loads on chromium steel balls.

BEARINGS (BRONZE)—Johnson Bronze Co., New Castle, Pa., has issued an illustrated 72-page catalog No. 390, giving advanced and complete information and data on sleeve type bronze bearings. Special sections on oil grooving, flanged bearings and bushings are included.

BUSHINGS (ROLLER)—A new catalog issued by Orange Roller Bearing Co. Inc., Orange, N. J., combines a discussion of the principles and qualities of the company's roller bushings with complete tables of engineering data on various types of these bushings. Capacities and dimensions are included, along with cross-sectional diagrams.

CASTINGS (STAINLESS STEEL) — A new pamphlet recently published by the Stainless Steel division of the Smith Steel Foundry Co., Milwaukee, describes and illustrates various types and kinds of stainless steel castings for use in machines. Six commonly used alloys are mentioned.

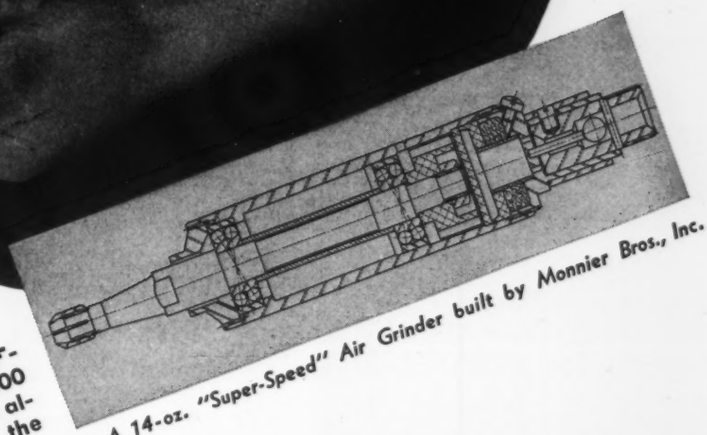
COUPLINGS (FLEXIBLE)—In a new catalog issued by Lovejoy Flexible Coupling Co., 5009 West Lake street, Chicago, L-R flexible couplings of various types are described and illustrated in color. List prices and dimensions are given. Full details of materials in the couplings help to emphasize their quality.

COUPLINGS (FLEXIBLE)—A new catalog No. 55 describing its different standard and special types of gear couplings has been issued by the John Waldron Corp., New Brunswick, N. J. In addition to cutaway views showing coupling construction and dimension drawings, this catalog gives rating tables and service factors along with a list of prices.

CYLINDERS (HYDRAULIC) — Hanna Engineering Works, 1765 Elston avenue, Chicago, has just published catalog 229 covering its hydraulic cylinders for working pressures up to 1500 pounds. Various types are individually illustrated and described. Diagrams and dimensions of all types are also included. A discussion of control valves and foot-operated valves rounds out the catalog.

ELECTRICAL EQUIPMENT—Harnischfeger Corp.,

Speeds OF 100,000 RPM REQUIRE GOOD BEARINGS



• A 14-oz. "Super-Speed" Air Grinder built by Monnier Bros., Inc.

WE DON'T KNOW how many other SKF-equipped machines operate at 100,000 RPM, but we do know that 100,000 RPM—or almost 2,000 *revolutions per second*—requires the utmost in bearings.

That SKF were selected is a tribute to special steels and skilled workmanship. For they are used not only on fast, delicate instruments where precision is vital, but on gigantic steel mills where brute strength—STAMINA—is required.

Any bearing that will stand up under these high speeds can be depended upon to operate satisfactorily on your machines. SKF Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa.

4233

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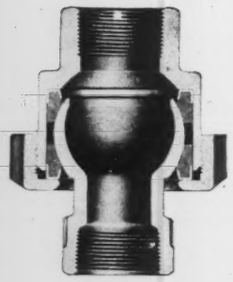
BALL BEARINGS

BARCO

Flexible Ball Joints

FOR EVERY REQUIREMENT



The Barco two-gasket type flexible ball joint is provided with two separate and distinct nonmetallic fluid tight seats on either side of the ball. Substantial angular movement as well as 360 degree swivel action adapt it to a wide range of applications.

This design insures absolute fluid tight flexibility either under suction or pressure.

Write for catalog 206 for complete details.

Barco Manufacturing Co.
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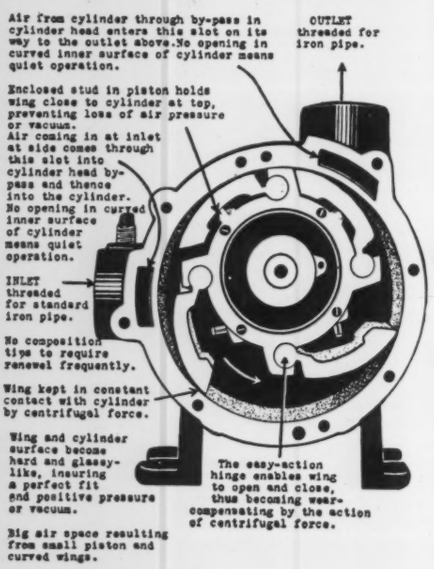
CHICAGO, ILL.
In Canada: The Holden Co., Ltd.

Standard Equipment on all sorts of Air Using Devices and used by the world's leaders . . . . .


Air from cylinder through by-pass in cylinder head enters this slot on its way to the outlet above. No opening in curved inner surface of cylinder means quiet operation.
OUTLET threaded for iron pipe.
Enclosed stud in piston holds wing close to cylinder at top, preventing loss of air pressure or vacuum.
Air coming in at inlet at side comes through this slot into cylinder head by-pass and thence into the cylinder. No opening in curved inner surface of cylinder means quiet operation.
INLET threaded for standard iron pipe.
No composition tips to require renewal frequently.
Wing kept in constant contact with cylinder by centrifugal force.
Wing and cylinder surface become hard and glassy-like, insuring a perfect fit and positive pressure or vacuum.
Big air space resulting from small piston and curved wings.
The easy-action hinge enables wing to open and close, thus becoming wear-compensating by the action of centrifugal force.

LEIMAN BROS.
PATENTED ROTARY AIR PUMPS
PRESSURE VACUUM
for use with
GAS AND OIL BURNERS

PAPER FEEDERS
Bottle Fillers
GAS MACHINES
AUTOMATIC DEVICES
MANY SIZES

A Machine That Takes Up Its Own Wear Automatically

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MAKERS OF GOOD MACHINERY FOR 50 YEARS

Milwaukee, has published bulletin C-5 entitled "Electrical Equipment for Cranes," covering the entire range of electrical equipment necessary for modern crane operation. Among the subjects discussed are motors, brakes and electrical controls.

GEARMOTORS—Data sheet M-31 covering new open and enclosed type gear reduction motors has been published by Barber-Colman Co., Rockford, Ill. Dimensions, illustrations, performance characteristics and diagrams round out the booklet. Net prices are given.

MOTORS—A new leaflet, No. 2183-A, entitled "Lo-Maintenance Direct Current Motors and Generators" has been released by Allis-Chalmers Mfg. Co., Milwaukee. Equipment is described and illustrated and details of construction are explained. Allis-Chalmers has also published a special leaflet, No. 2125-C, on explosion-proof motors for protection in fume-laden atmospheres.

STEELS (ALLOY)—Ry-Alloy steel, specially developed to meet the demand for an oil-hardening steel which, when heat treated, will develop high hardness and deep penetration, and have minimum distortion and freedom from cracking, is described in a new bulletin issued by Joseph T. Ryerson & Son Inc., Chicago.

STEELS (ALLOY)—The process of Nitriding is discussed by V. O. Homerberg, technical director, The Nitralloy Corp., 230 Park avenue, New York, in a new booklet. Designers will find the discussion of interest because of the particular information on Nitralloy, the alloy steels most suitable for case-hardening by this process.

THERMOMETER—A new leaflet has been published by Wheelco Instruments Co., Chicago, describing its industrial indicating control thermometer, series 4200.

Professional Viewpoints

(*Concluded from Page* 42)

the stress formula as written in the article.

The reduction of strength at high temperatures is certainly a serious consideration as touched upon but not discussed extensively in the article. This consideration, it was suggested, is a matter for individual research.

Effects of the change of the coefficient of expansion with temperature and especially near any critical temperature or calescent point had been considered seriously. This phenomenon is often given by metallurgists as the sole cause of thermal stress failure just as engineers seek a mechanical cause. Since so many failures occur at comparatively low temperatures and since not much is known about the existence or position of critical temperatures in white metals, bronzes, cast iron, etc., this influence was not included in the article.

H. F. SHEPHERD
Beaumont, Tex.

QUALITY IS MORE THAN SKIN DEEP

SO WE LOOK DEEP UNDER THE SURFACE

. . . . . OF OUR SPECIAL PARKALOY ROD
With the finest of metallographic equipment at hand, the Parker-Kalon Laboratory can look right into this special chrome nickel alloy. Make sure that grain size, carbon content, and structure are 100 percent correct.

. . . . . OF OUR FINISHED SOCKET SCREWS There's no guessing about their properties. The photomicrograph magnifies grain size and other structural characteristics to 1000 diameters. Tells whether the product meets the new high standards set by Parker-Kalon.

An Example of the QUALITY-CONTROL that leads critical buyers to demand PARKER-KALON

Spend a few minutes in the $250,000 Parker-Kalon Laboratory and you will understand how Parker-Kalon produced Socket Screws that set a new standard of quality. You'll know why these Screws have become famous for possessing ALL essential qualities to an unvarying degree.

In the whole screw industry there is nothing to compare with this laboratory and its Quality Control facilities. It is a positive guarantee of perfection in every Parker-Kalon Cold-forged Socket Screw. Your severest tests will be welcomed. Send for free samples and bulletin of details.

PARKER-KALON CORP., 212 VARICK STREET, NEW YORK

PARKER-KALON Cold-Forged SOCKET SCREWS

Business and Sales Briefs

DUE TO increased use of Phillips recessed head screws, American Screw Co. has licensed the following: Chandler Products Co., Euclid, O.; Scovill Mfg. Co., Waterbury, Conn.; Pheoll Mfg. Co., Chicago; and Lamson & Sessions Co., Cleveland.

♦

Formerly assistant to the manager, G. S. Alcorn has been named sales manager of the wiring device section of General Electric appliance and merchandise department, Bridgeport, Conn.

♦

Opening of a factory branch office in Seattle, Wash., located at 1914 Utah avenue, has been announced by The Lincoln Electric Co., Cleveland. J. B. McCormick, formerly representing the company in Fresno, Calif., and recently in Spokane, Wash., will be in charge of the new branch.

♦

Appointment of Milton J. Sandling as vice president in charge of sales of Howell Electric Motors Co., has recently been made, according to an announcement by Aubrey Flood, president of the company. Mr. Sandling's experience includes over twenty years of handling motor sales-engineering problems.

♦

Houston offices of Allis-Chalmers Mfg. Co. have been moved to 1719 McKinney avenue. K. P. Ribble, district manager, continues in charge.

♦

Three new distributors have been added to represent Diamond Chain & Mfg. Co. on its line of roller chains and sprockets, conveyor chains and flexible couplings. These are: Barret Hardware Co., Joliet, Ill.; Iowa Machinery & Supply Co., Des Moines, Ia.; and Lakeshore Machinery & Supply Co., Muskegon, Mich.

♦

John P. Case, who has been in charge of plastics activities for Consolidated Molded Products Corp., for a number of years, resigning as president of that company only a short time ago, has been appointed manager of the plastics department of The S. S. White Dental Mfg. Co., Industrial Division. His headquarters will be at 10 East Fortieth street, New York.

♦

Change of address for Mark G. Mueller to 1644 Blake street, Denver, Colo., has recently been announced by Ward Leonard Electric Co., manufacturer of electric controlling devices. Mr. Mueller is the company's rep-

2 BIG ADVANTAGES

--get both by specifying KNURLED

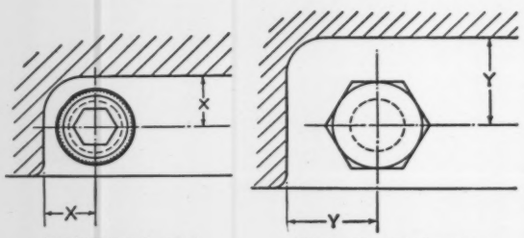
UNBRAKO

SOCKET HEAD CAP SCREWS

Fig. 1434 Pats. Pend.

1-MORE COMPACT DESIGNS

A decided saving is possible in clearance, material, weight and cost. Notice how close to the corner the "Unbrako" is placed, in the plan view below. Compare with the placement of ordinary screws which require setting back to allow for hex head and wrench. *See—and save—the difference!*



See how the Knurled "Unbrako" snuggles right into the corner.

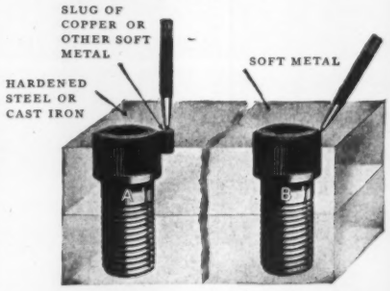
Notice the great open spaces necessary for the hex head and wrench.

2-LOCKS EASILY

The Knurled "Unbrako" can be locked firmly in place by two simple, effective methods.

When the screw is inserted in hardened metal, the soft metal slug (as shown by "A" in the illustration) locks it securely by being spread into the knurls of the screw with the aid of a locking tool. And—in soft metal, illustration "B" shows the easy way of locking.

No other screw has all the advantages of this modern, knurled "Unbrako"!



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STANDARD PRESSED STEEL CO.

BRANCHES BOSTON DETROIT INDIANAPOLIS

JENKINTOWN, PENNA.

BOX 102

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A wide variety of sizes and types of bearings and bushings indicates extensive production facilities and manufacturing knowledge. But it also serves to symbolize the great breadth of Federal-Mogul's experience in this specialized field.

How the benefits of this wide and varied experience can be applied to your product is well illustrated by the newer insert-type bearing. Federal-Mogul developed and has produced millions of these bearings for automotive use.

A machine manufacturer with a bearing problem came to Federal-Mogul and this organization successfully adapted the automotive insert-type bearing to his product, resulting in remarkable performance improvements and cost economies.

To any machine or appliance manufacturer with a bearing or bushing problem, or who is planning new units, we suggest consultation with Federal-Mogul's metallurgical and engineering laboratories as the first step towards modernizing bearing applications. This service is yours without obligation. The free book illustrated here outlines the *varied* experience and facilities of Federal-Mogul in the bearing field. A request on your letterhead brings your copy. Address:

FEDERAL-MOGUL CORPORATION, 804 Shoemaker Ave. • *Detroit, Mich.*

STEEL-BACK and BRONZE-BACK, BABBITT-LINED and CADMIUM-SILVER-COPPER LINED BEARINGS

FEDERAL Mogul

BRONZE BUSHINGS, WASHERS, CASTINGS and BARS (cored and solid); BABBITT METALS FOR ALL USES

resentative in the states of Colorado, western Nebraska, northern New Mexico and nearly all of Wyoming.

♦

Industrial Clutch Co., Waukesha, Wis., has named C. M. Eason as president of the company, E. R. Estberg, treasurer, and John J. Pfeffer, secretary. Mr. Eason has recently designed a friction clutch for punch presses.

♦

R. B. Tripp has been elected vice president of Ohio Forge & Machine Corp., Cleveland. He will retain his position as sales manager.

♦

Formerly southwest district sales manager, Alemite division, Stewart-Warner Corp., Chicago, J. C. Hager has been transferred to take charge of the company's southeastern sales territory.

♦

The cast products division of National Radiator Corp., Johnstown, Pa., has recently announced the appointment of new representatives in New York City and Chicago territories. These are Eastern Steam Specialty Co. and Faville Le-Vally Corp., respectively.

♦

With headquarters at 400 West Madison street, Chicago, R. E. Greenwood will represent the American Chain division, American Chain & Cable Co. Inc., as district sales manager for the Chicago territory. Mr. Greenwood succeeds G. B. Kutz who has been transferred to York, Pa., as assistant to general manager of sales of the division. R. C. Brenizer has been appointed Philadelphia district sales manager with headquarters at Second and Diamond streets, succeeding Mr. Greenwood.

♦

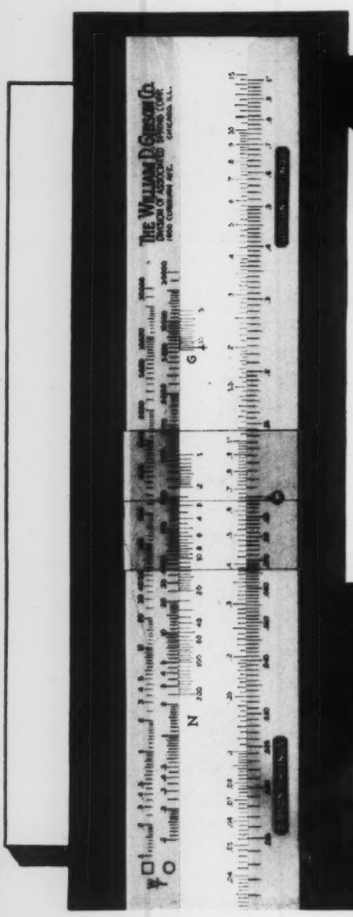
The Resinox Corp., manufacturer of synthetic resins and molding compounds, has recently announced the appointment of Charles Lichtenberg as vice president of the corporation.

♦

For several years assistant to the president of Borg-Warner Corp., Chicago, N. K. Van Osdol has been appointed to represent Ingersoll Steel & Disc Division of that corporation in Detroit and Eastern Michigan areas. Offices are at 6432 Cass avenue, Detroit.

♦

Russell A. Blanchard, for the past fourteen years purchasing agent of Detroit Brass & Malleable Works, has been appointed Detroit district sales representative of Extruded Metals Inc., Belding, Mich., manufacturer of a varied line of extruded shapes in brass, bronze, copper, aluminum and special alloys. This company has recently been organized with J. L. Barrett, formerly manager of extrusion activities of Bohn Aluminum & Brass Corp., as president. W. Harvey Smith, also previously with the Bohn company, is vice president in charge of operations.



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Figures rapidly and accurately the variables in compression and extension springs. Computes torsional stresses on commonly used combinations of dimensions. Indicates loads, deflection and other necessary data. Brief instruction book with each rule. Send for it now.

WILLIAM D. GIBSON CO.

DIV. OF ASSO. SPRING CORP. 1800 CLYBOURN AVE., CHICAGO, ILL.

YOURS IS READY!

USE THIS REPLY FORM

Gentlemen: Please send slide rule and booklet, no charge.

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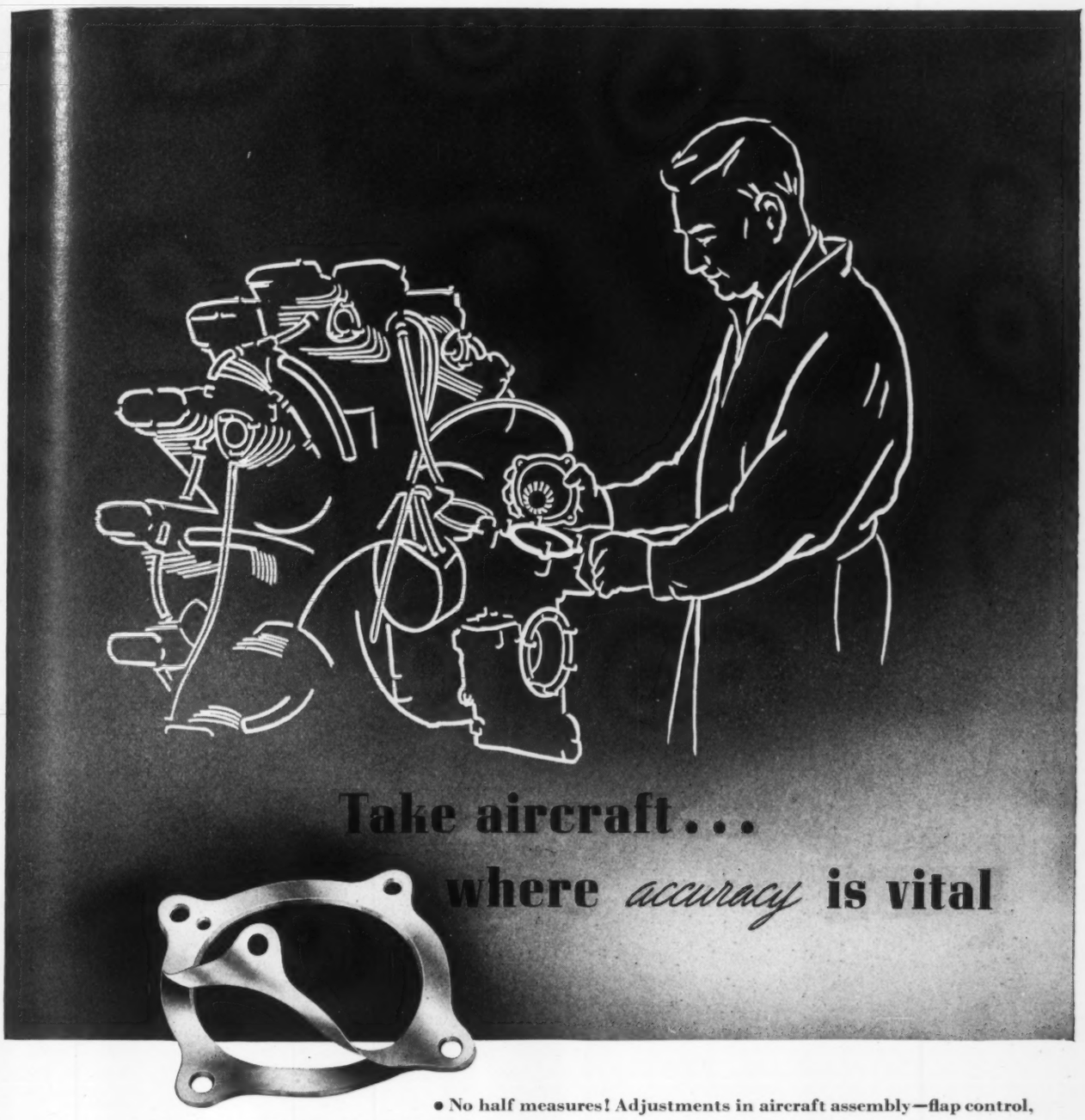
TITLE _____

FIRM _____

STREET _____

CITY _____ STATE _____ MD



• No half measures! Adjustments in aircraft assembly—flap control, stabilizer, tail chassis, adjustable-pitch propeller, engine, instruments—*all* must be held to extreme accuracy. • "Without Laminum shims it would be practically impossible to adjust certain assemblies to the close limit required"—this from a top-ranking airplane builder. • Laminum shims are doing the *same* job throughout industry . . . and at the same time speeding precision assembly and bringing down costs. Paper-thin laminations (your choice of .003 or .002 inch, or less, in thickness) are simply *peeled* off the brass shim as needed. As easy as that—in assembly or service adjustments!

Laminum shims are furnished cut to your exact specifications. For maintenance requirements, Laminum sheets or strips are obtainable from leading mill supply houses.

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CLEVELAND DALLAS HOUSTON MILWAUKEE TULSA

Application Chart FREE . . .
A file folder that illustrates and classifies the many types of laminated shim applications. For handy, practical use. With it a Laminum sample. Write for it.

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THE SOLID SHIM THAT *peels* FOR ADJUSTMENT

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INDEX TO ADVERTISERS

Letter "S" refers to pages in Supplement

Abart Gear & Machine Co. *
Alemite 53
Allen-Bradley Co. 53-S, 54-S
Allis-Chalmers Mfg. Co. 22
American Brass Co., The *
American Cable Div., American Chain & Cable Co., Inc. 65-S
American Chain & Cable Co., Inc. 65-S
American Engineering Co. 43-S
American Metal Hose Branch, The American Brass Co. 49
American Screw Co. *
American Steel & Wire Co. 16
Ampco Metal, Inc. *
Associated Spring Corp. 58
Auburn Button Works, Inc. 47-S
Baldwin-Duckworth Chain Corp. 57
Bantam Bearings Corp. 66
Barco Manufacturing Co. *
Bijur Lubricating Corp. 56-S
Bodine Electric Co. 68-S
Bond, Charles, Co. 19-S
Boston Gear Works, Inc. 46
Bristol Co., The 62
Brown & Sharpe Mfg. Co. 15
Bruning, Charles, Co., Inc. *
Bunting Brass & Bronze Co., The 63
Carnegie-Illinois Steel Corp. 17
Cerro De Pasco Copper Corp. 11-S
Chain Belt Company *
Chandler Products Co. 64
Chicago Metal Hose Corp. 52
Chicago Molded Products Corp. 4
Chicago Rawhide Mfg. Co. 4-S
Cleveland Worm & Gear Co. 69-S
Clifford Mfg. Co. 16, 63
Columbia Steel Co. *
Continental Screw Co. 66-S
Conway Clutch Co. *
Corbin Screw Corp., The 51-S
Crocker-Wheeler Electric Mfg. Co. 9
Cuno Engineering Corp. Inside Front Cover
Cutler-Hammer, Inc. 74-S
Dayton Rubber Mfg. Co., The 57-S
De Laval Steam Turbine Co. *
Delco Products Division, General Motors Corp. 21
Diamond Chain & Mfg. Co. *
Dow Chemical Co., The 17-S
Drop Forging Association *
Dumore Co., The 62
Du Pont, E. I., de Nemours & Co., Inc. *
Eagle Pencil Co. 54
Eclipse Moulded Products Co. *
Elastic Stop Nut Corp. 10, 11
Electro Metallurgical Co. 9-S
Fafnir Bearing Co., The 69
Farval Corp., The 69-S
Federal-Mogul Corp. 50-S
Foote Bros. Gear & Machine Corp. 55
Foote Gear Works, Inc. *
Formica Insulation Co., The 62-S
Galland-Henning Mfg. Co. *
Garlock Packing Co., The 70-S
Gear Specialties, Inc. 5-S, 6-S, 7-S, 8-S, 8, 56
General Electric Co. *
General Electric Vapor Lamp Co. 55-S
General Radio Co. 70
Gibson, William D., Co. *
Graham Transmissions, Inc. 58-S
Guardian Electric Co. 63-S
Guardian Utilities Co. 3-S
Hanna Engineering Works 40-S
Hanniffin Manufacturing Co. 71-S
Hart Manufacturing Co., The 69-S
Hilliard Corp., The *
Hyatt Bearings Division, General Motors Sales Corp. 47
Ideal Commutator Dresser Co. 65-S
International Nickel Co., Inc., The 45
James, D. O., Mfg. Co. 67-S
Johnson Bronze Co. 73
Jones, W. A., Foundry & Machine Co. 42-S
Keuffel & Esser Co. 44
Koh-I-Noor Pencil Co., Inc. *
Laminated Shim Co., Inc. 71
Lamson & Sessions Co., The *
Leiman Bros., Inc. 66
Leland Electric Co., The *
Lewellen Manufacturing Co. 44-S
Lima Armature Works, Inc., The 71-S
Lincoln Electric Co. 74
Linde Air Products Co., The *
Link-Belt Co. 39-S, 41-S
Logansport Machine, Inc. 20-S
Lovejoy Flexible Coupling Co. 60-S
McGill Mfg. Co. 50
Marlin-Rockwell Corp. *
Master Electric Co. Inside Back Cover
Michigan Tool Co. 45-S
Micro Switch Corp. 65-S
Monitor Controller Co. 16-S
Morse Chain Co. 18-S
National Acme Co. *
National Screw & Mfg. Co. *
National Tube Co. *
New Departure Division, General Motors Corp. 6
New Jersey Zinc Co., The 18
Norma-Hoffmann Bearings Corp. 61
Ohio Gear Co., The 46-S
Oilgear Company, The 63-S
Ozalid Corporation 54
Parker-Kalon Corp. 67
Pease, C. F., Co., The *
Peck Spring Co., The 48-S
Peerless Electric Co., The *
Pheoll Mfg. Co. 59-S
Philadelphia Gear Works 52-S
Racine Tool & Machine Co. *
Raymond Mfg. Co. 12-S, 13-S
Reeves Pulley Co. *
Richardson Co., The 58
Rivett Lathe & Grinder, Inc. 49-S
Rockford Drilling Machine Div. of Borg-Warner Corp. *
Roper, Geo. D., Corp. 60
Russell, Burdsall & Ward Bolt & Nut Co. *
Ruthman Machinery Co. 20
Scovill Mfg. Co. 19
Shafer Bearing Corp. 65
Shakeproof Lock Washer Co. 61-S
SKF Industries, Inc. 14
Speedway Mfg. Co. *
Spring Washer Industry 48
Square D Co. 51, 68
Staedtler, J. S., Inc. 59
Standard Pressed Steel Co. 53
Steel Founders' Society of America 63-S
Stewart-Warner Corporation *
Stow Manufacturing Co., Inc. 73-S
Sundstrand Pump Division, Sundstrand Machine Tool Co. 63
Tennessee Coal, Iron & Railroad Co. 3
Thompson-Bremer & Co. Back Cover
Timken Roller Bearing Co. 71-S
Tomkins-Johnson Co., The *
Torrington Co., The 43
Trico Fuse Mfg. Co. 52
Tuthill Pump Co. 61-S
Twin Disc Clutch Co. *
Union Carbide & Carbon Corp. 16, 63
United States Steel Corp. 41
United States Steel Products Co. 12, 13
Veeder-Root, Inc. 67-S
Vickers, Inc. 64
Victor Electric Products, Inc. *
Viking Pump Co. 10-S
Wagner Electric Corp. 67-S
Waldron, John, Corp. 14-S, 15-S
Westinghouse Electric & Mfg. Co. 2-S
Whitney Chain & Mfg. Co., The 61-S
Wisconsin Motor Corp. 72-S
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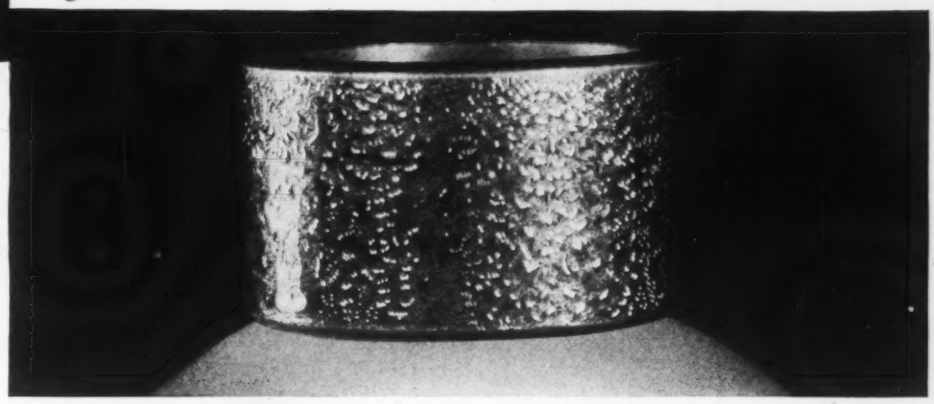

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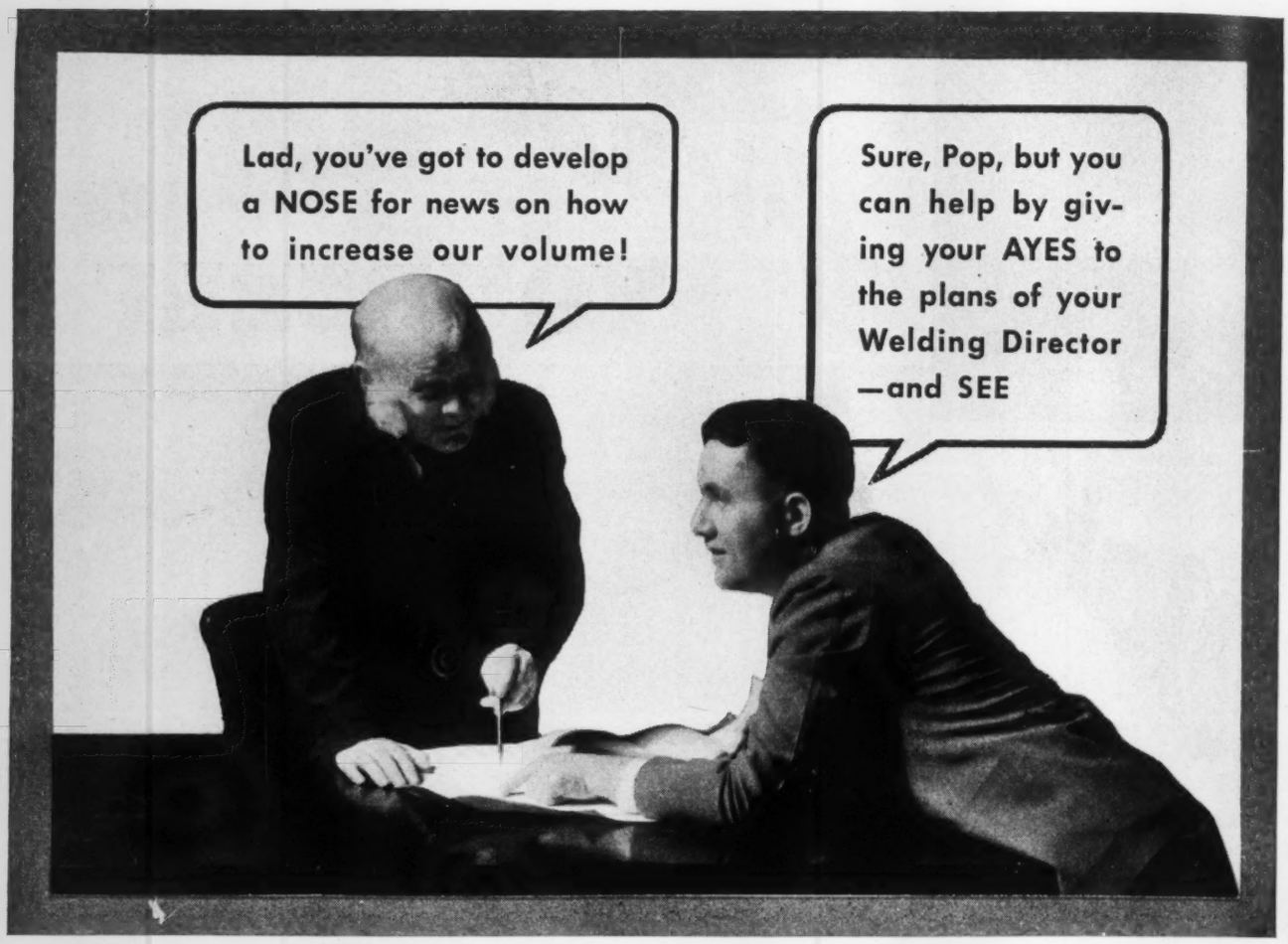
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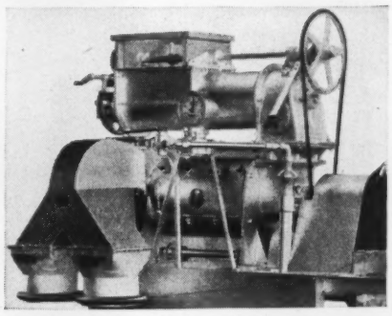

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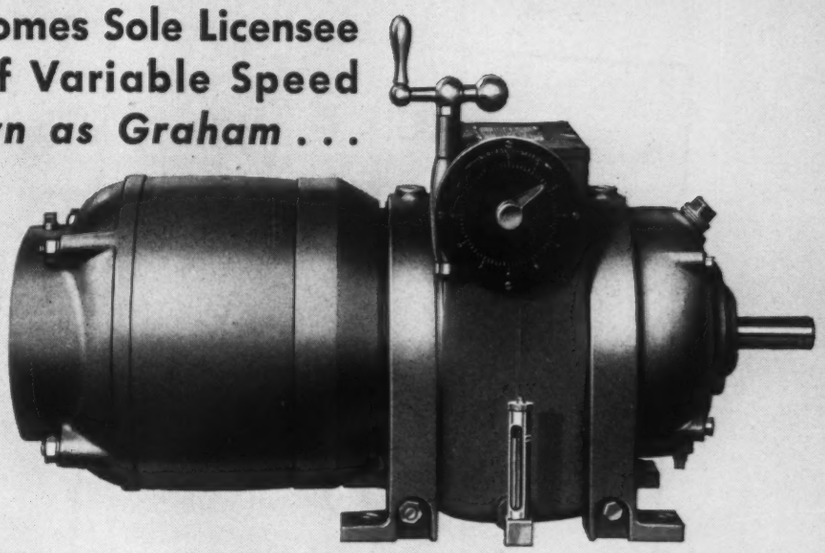

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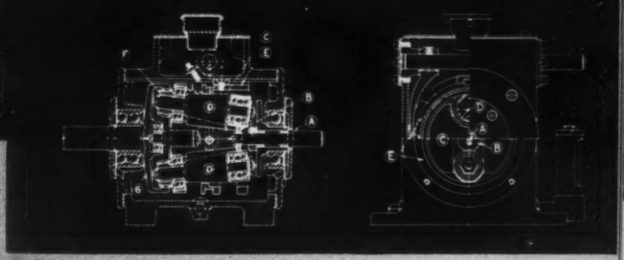

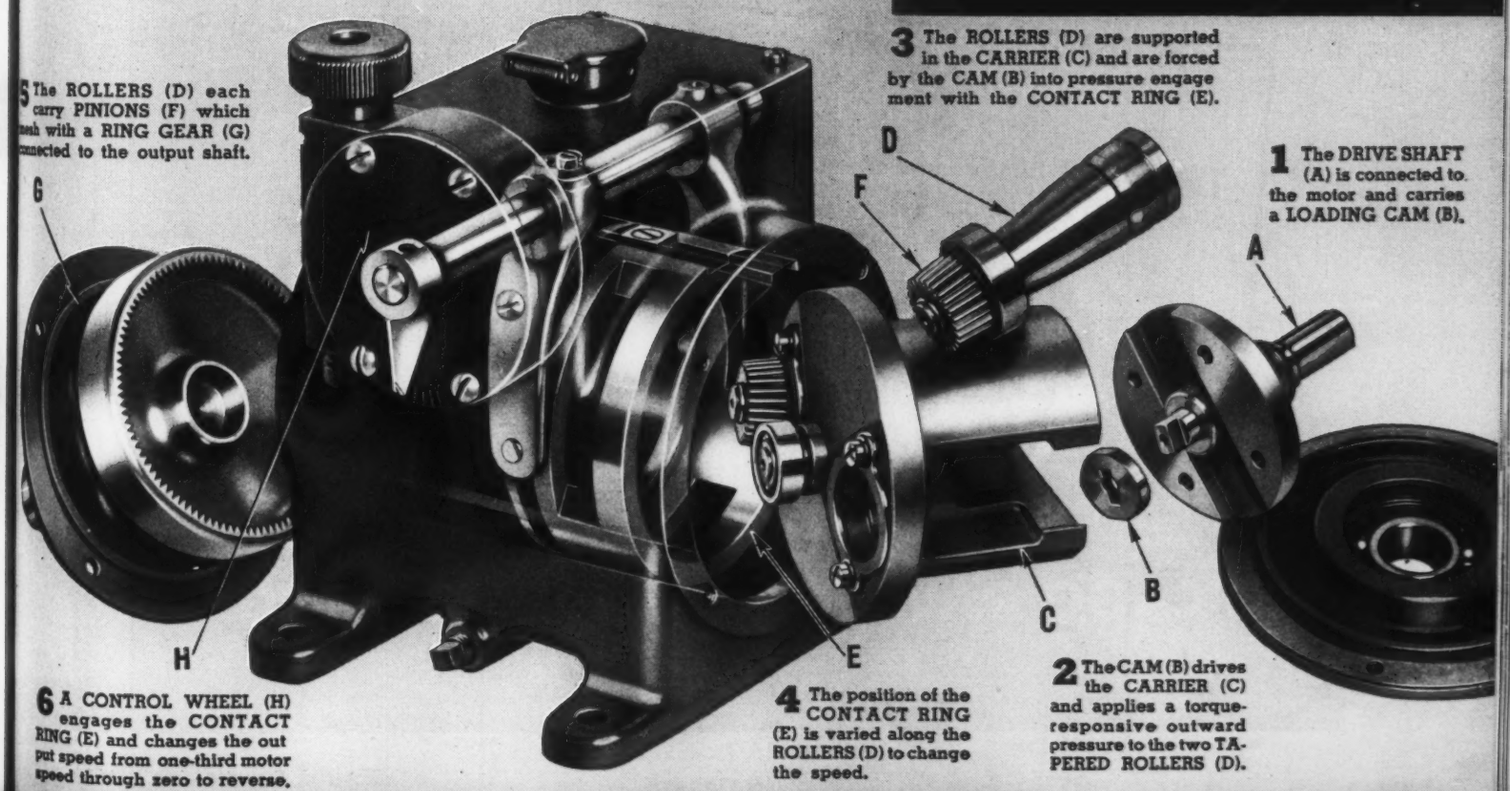

1 The DRIVE SHAFT (A) is connected to the motor and carries a LOADING CAM (B).

2 The CAM (B) drives the CARRIER (C) and applies a torque-responsive outward pressure to the two TAPERED ROLLERS (D).

3 The ROLLERS (D) are supported in the CARRIER (C) and are forced by the CAM (B) into pressure engagement with the CONTACT RING (E).

4 The position of the CONTACT RING (E) is varied along the ROLLERS (D) to change the speed.

5 The ROLLERS (D) each carry PINIONS (F) which mesh with a RING GEAR (G) connected to the output shaft.

6 A CONTROL WHEEL (H) engages the CONTACT RING (E) and changes the output speed from one-third motor speed through zero to reverse.

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